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SELECTED
WATER RESOURCES
ABSTRACTS

A monthly publication of the Geological Survey
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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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SELECTED WATER RESOURCES ABSTRACTS

1. NATURE OF WATER

1A. Properties

NALCO WATER HANDBOOK.
For primary bibliographic entry see Field 5F.
W89-01824

2. WATER CYCLE

2A. General

RECHARGE-DISCHARGE FUNCTION OF WETLANDS NEAR JUNEAU, ALASKA: PART II. GEOCHEMICAL INVESTIGATIONS,
Syracuse Univ., NY. Dept. of Geology.
D. I. Siegel.
Ground Water GRWAAR, Vol. 26, No. 5, p 580-586, September-October 1988. 3 fig, 2 tab, 30 ref.

Descriptors: *Hydrologic budget, *Recharge, *Wetlands, *Bogs, *Alaska, *Geohydrology, Hydrology, Fens, Juneau, Solutes, Conductivity, Specific conductivity, Metals, Groundwater, Peat, Surface water.

The recharge-discharge function of bogs, fens, and forested wetlands near Juneau, AK was investigated by comparing concentrations of solutes and measurements of specific conductance in wetland groundwater and surface water. Average concentrations of major metals define major wetland types. Bogs and fens are in recharge areas and have the most dilute groundwater. Forested wetlands are in discharge areas and have groundwater chemistry similar to that found in domestic wells completed in mineral soils. Concentration profiles of total dissolved metals in blanket bogs were compared to theoretical concentration profiles based on the diffusion of solutes from mineral soil into the overlying peat. All observed concentration profiles are less than predicted by diffusion, and show that the blanket bogs are long-term recharge zones. (Author's abstract)
W89-01403

FOREST HYDROLOGY AND ECOLOGY AT COWEETA.
Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. 469p. Edited by Wayne T. Swank and D. A. Crossley.

Descriptors: *Forest hydrology, *Ecology, *Coweeta, *North Carolina, *Research facilities, *Symposium, *Ecosystems, Geochemistry, Watersheds, Forest watersheds, Streams, Ecological effects, Pesticides, Water resources development, Acid rain, Air pollution, Research priorities.

Papers given during a 3-day Symposium held in Athens, Georgia, in October 1984 to commemorate 50 years of research at the Coweeta Hydrologic Laboratory summarize and highlight major contributions from Coweeta to hydrologic and ecological understanding of Southern Appalachian forested lands. More than 550 published papers document the research findings at Coweeta and it was not possible to include all contributions of the program. Principles of biogeochemical cycling are illustrated by watershed studies combined with research on major processes affecting nutrient cycles of forest ecosystems. In addition to in-depth analyses of terrestrial and stream processes, the breadth of coverage includes historical perspectives and relevance of ecosystem science to management needs. Alterations of terrestrial and stream processes and their interactions with man-made disturbances such as cutting, logging, species conversions, use of pesticides, and atmospheric deposition are documented. The importance of long-term research in establishing the baseline status of ecosystems and responses to natural disturbances such as insect infestations is illustrated. In a broader sense, the Coweeta research effort is considered from a perspective of national and international forest hydrology and ecology programs. (See W89-01691 thru W89-01713) (Lantz-PTT)
W89-01691

INTRODUCTION AND SITE DESCRIPTION,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
W. T. Swank, and D. A. Crossley.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 3-16, 12 fig, 3 tab.

Descriptors: *Forest hydrology, *Coweeta, *North Carolina, *Research facilities, Research priorities, Ecosystems, Ecological effects, Resource development, Geohydrology, Geology, Climatology, Nutrients, Hydrology.

The Coweeta Hydrologic Laboratory was established 50 years ago as a testing ground for certain theories in forest hydrology. That research required development of a firm data base describing the hydrologic cycle in watersheds. Later, in 1968, efforts began to establish an extensive data base on nutrient cycling phenomena in Coweeta watersheds with joint USDA Forest Service-National Science Foundation funding. This research was a logical extension of the research on watershed hydrology. Both types of research have been based on an ecosystem concept, explicitly for nutrient cycling studies and implicitly even for early studies in forest hydrology. The research program at Coweeta represents a continuum of theory, experimentation, and application using watersheds as landscape units. Two underlying philosophies have guided the research approach at Coweeta: (1) that the quantity, timing, and quality of streamflow provide an integrated measure of the success or failure of land management practices, and (2) good resource management is synonymous with good ecosystem management. Response to disturbance has frequently been used as a research tool for interpreting ecosystem behavior. The use of perturbation or disturbance has allowed specific hypotheses to be tested with subsequent revision and development of theories and application of results when appropriate. The Coweeta Basin is discussed and a historical account given of the establishment and development of the program and facilities. (See also W89-01691) (Lantz-PTT)
W89-01692

CLIMATOLOGY AND HYDROLOGY,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
L. W. Swift, G. B. Cunningham, and J. E. Douglass.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 35-55, 16 fig, 4 tab.

Descriptors: *Climatology, *Hydrological regime, *Streamflow, *Forest watersheds, *Rainfall-runoff relationships, Precipitation, Elevation, Seasonal variation, Annual runoff, Evapotranspiration.

Streamflow from an undisturbed forested watershed is the net result of the physiography of the catchment and its climate. Various hydrologic response characteristics correlate well with watershed elevation and it has been used as a predictor of streamflow response. Elevation, however, is a surrogate variable representing several other variables whose exact physical relationships to streamflow are incompletely defined at this time. Precipitation amount and timing have the greatest influence upon streamflow. Precipitation increases with elevation along the east-west axis of the Basin, but is not closely correlated with elevation along the slope for the north- and south-facing watersheds. At all elevations, precipitation is distributed fairly evenly throughout the year with large individual storms occurring in nearly every month. Generally, monthly total precipitation is less in April, late summer, and fall. Lagged streamflow response with snowmelt is a minor factor, because heavy snows and long lasting snowpacks are rare. The majority of rains have short durations and low intensities, but when large, high intensity storms do occur, they occur with shorter recurrence intervals than predicted from standard reference works. On an annual basis, precipitation exceeds evapotranspiration demand and streams flow year round. Solar radiation is the primary source of energy for evapotranspiration. Because evapotranspiration rates are sensitive to temperature, humidity, and wind, evapotranspiration also can be correlated with elevation. Soil depth decreases and slope steepness increases with elevation. Both factors reduce the ability of the watershed to retain precipitation and thus increase the percentage that appears as streamflow. Upper elevation watersheds have lower precipitation-runoff factors because they have less soil moisture storage capacity, return a higher percentage of precipitation as quickflow, and have less evapotranspiration demand to create soil moisture storage opportunity before a rain. (See also W89-01691) (Lantz-PTT)
W89-01694

CHARACTERIZATION OF BASELINE PRECIPITATION AND STREAM CHEMISTRY AND NUTRIENT BUDGETS FOR CONTROL WATERSHEDS,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
For primary bibliographic entry see Field 2K.
W89-01695

RESEARCH ON INTERCEPTION LOSSES AND SOIL MOISTURE RELATIONSHIPS,
Northeastern Forest Experiment Station, Parsons, WV. Timber and Watershed Lab.
J. D. Helvey, and J. H. Patric.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 129-137, 5 fig, 2 tab.

Descriptors: *Soil water, *Interception, *Infiltration, *Forest hydrology, *Evapotranspiration, *Rainfall-runoff relationships, *Soil-water-plant relationships, Streamflow, Transpiration, Riparian waters.

The unsaturated zone of a watershed has been called the no man's land of hydrology and evapotranspiration a term of ignorance. Much has been learned about the amount and timing of soil moisture loss through trees, and of that same water escaping use by trees to ultimately become streamflow. Fuller understanding of both fluxes were important in the formulation of the variable source area concept of water delivery to streams. Studies of soil moisture played a key role in the development of that concept, and suggested that the combination of deep soils and frequent rainfall at Coweeta may permit vegetation to transpire at near-potential rates at all times. This conclusion is important for the interpretation of water yield results and their applicability to other areas that receive less rainfall. The hypothesis that streamside trees and shrubs are unusually heavy water users because their roots penetrate the water table, has been tested. However clearcutting a riparian zone showed that although diurnal fluctuations in streamflow decreased, streamflow increase was no larger than might be expected from cutting an equal area elsewhere on the experimental watershed. Thus, the riparian effect, so important along channels in arid lands, appears to be lacking under Coweetas per humid climate. The riparian effect is of negligible consequence in areas where soil moisture remains readily available on all parts of the watershed throughout the year. Other processes such as nutrient cycling, erosion rates, and rates of revegetation after disturbance must be considered in light of the soil moisture levels at the study site. Functional relationships existing at Coweeta may not apply to other areas where soil moisture relationships differ significantly. (See also W89-01691) (Lantz-PTT)
W89-01700

FOREST ECOSYSTEM STABILITY: REVISION OF THE RESISTANCE-RESILIENCE MODEL IN RELATION TO OBSERVABLE MACROSCOPIC PROPERTIES OF ECOSYSTEMS,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
J. B. Waide.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag,

New York. 1988. p 383-405, 3 fig, 2 tab.

Descriptors: *Forests, *Forest ecology, *Model studies, *Ecosystems, *Equilibrium, Theoretical analysis, Energy dissipation, Energy conversion, Degradation, Recycling.

The organization and dynamics of an ecosystem depend on functional processes operating at the scale of observation. Factors which disrupt the space-time coupling of the ecosystem to a specific physicochemical environment decouple the processes of energy dissipation and element cycling from the existing structure, and force the ecosystem into a new organization state. Viewed in terms of the inverse relation between mass and metabolism inherent in biological organization, the original concepts of resistance and resilience were reinterpreted theoretically as scaling variables which reflect the space-time coupling of specific biotic assemblages to physicochemical environments. However, the concepts of resistance and resilience may be usefully applied to post-disturbance responses of different local realizations of a given ecosystem type exhibiting comparable levels of structure and function at similar scales of space and time. In this restricted context, it is important to determine factors which prevent the ecosystem from assuming a new organizational state following disturbance (ecosystem resistance), and which regulate the rate of recovery to the undisturbed or nominal state (ecosystem resilience). These two components of ecosystem relative stability are related to characteristics of biogeochemical element cycles, particularly the presence of large element storages both in abiotic pools and in living and slowly decaying organic pools (resistance) and the rate at which elements are mobilized and recycled by biota (resilience). The macroscopic approach adopted here clarifies much of the existing confusion concerning ecosystem stability, and partially resolves conflicting approaches to stability among population and ecosystem ecologists. Implicit in the present theoretical treatment of ecosystems is the concept of conditional stability, suggesting that undue emphasis has been placed on this topic in the past. However, the fact that conditional stability is a direct and necessary consequence of the theoretical treatment of the ecosystem as a hierarchical biogeochemical system is not a trivial result. Rather, this theoretical approach provides the basis for going beyond past confusions and debates to address more useful questions in the future. (See also W89-01691) (Lantz-PTT)
W89-01712

EUROPEAN EXPERIENCES IN LONG-TERM FOREST HYDROLOGY RESEARCH,
Swiss Forest Research Inst., Birmensdorf.
H. M. Keller.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 407-414, 2 fig.

Descriptors: *Europe, *Forest watersheds, *Forest hydrology, *Hydrologic studies, Streamflow, Long term planning, Research priorities.

In the early days, only a few people were involved in the operations of watershed research. Today, with the increasing interest of ecologists in such studies a much larger group is involved. Some cooperative projects look interdisciplinary on paper; others list only one institute and one name. It is a common experience that successful cooperative research depends on: (1) the character of individual persons; (2) the number of persons involved in a project; (3) the continuity of the composition of the group; and (4) moral support from administrators to engage in cooperative work. The influence of forest cover on streamflow was and still is a primary focal point of forest hydrology research in Europe. Increasing population size in many countries, greater need to use water for various purposes, the increasing pollution of rivers and lakes, and the need for improving the quality of the environment are all circumstances which in the 1960s created a need to incorporate water quality considerations into long-term forest hydrology projects. The following are studies and their starting date currently ongoing in Europe: Switzerland: Alptal (SZ) 1968; Sweden: Kloten 1968; Great Britain: Plinlimon (Wales) 1971; FED. Rep. Germany: Krofdorf (Hessen) 1971, Grosse Ohe (Bavaria) 1978; Spain: l'AVIC (Barcelona) 1978; France: Mont Lozere (Toulouse) 1981; and Italy: Cordon (Veneto) 1984. These few are only examples; there are many more operated by various agencies. Only the future, however, can tell which of these will be long-term study sites and which will be abandoned after only a few years of investigation. (See also W89-01691) (Lantz-PTT)
W89-01713

APPLIED HYDROGEOLOGY,
Wisconsin Univ.-Oshkosh.
C. W. Fetter.
Merrill Publishing Co., Columbus, Ohio. 1988. 592 p.

Descriptors: *Geohydrology, *Groundwater movement, Hydrology, Evaporation, Precipitation, Groundwater recharge, Soil water, Wells, Groundwater management, Runoff, Streamflow, Groundwater pollution, Model studies.

An introduction to geohydrology at either advanced undergraduate or dual graduate/undergraduate levels is given, with emphasis on methods of site characterization, groundwater monitoring, contaminant hydrogeology, and computer modeling. Application mathematics to problem solving rather than derivation of theory. To this end, there are many example problems with step-by-step solutions. Case studies in many chapters enhance understanding of occurrence and movement of groundwater in a variety of geologic settings. Chapters discuss: evaporation and precipitation; runoff and streamflow; soil moisture and groundwater; principles of groundwater flow; groundwater flow to wells; regional groundwater flow; geology of groundwater occurrence; water chemistry; water quality and groundwater contamination; groundwater development and management; field methods; and groundwater models. (See also W89-01783) (Lantz-PTT)
W89-01801

PROCEEDINGS OF THE FOREST-ATMOSPHERE INTERACTION WORKSHOP.
For primary bibliographic entry see Field 5B.
W89-01815

TRACER METHODOLOGY IN HYDROLOGY,
Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
E. Gaspar.
IN: Modern Trends in Tracer Hydrology. Volume I. CRC Press, Inc., Boca Raton, FL. 1987. p 81-107, 7 fig.

Descriptors: *Hydrologic studies, *Tracers, *Model studies, *Groundwater movement, *Geohydrology, Hydrology, Flow patterns, Aquifers, Hydrologic models, Hydraulic models, Mathematical models.

The use of tracer techniques in investigations of aquifer resources presupposes that tracers are introduced into the aqueous system and then identified at points of interest and measured. A hydrological process is a concept of the way in which a hydrological phenomenon occurs; therefore, each hydrological phenomenon has a corresponding hydrological process. Two processes- the deterministic and the nondeterministic - are considered major. The deterministic process of a phenomenon is an evolution that obeys the law according to which a given cause generates a particular effect rather than another. In the nondeterministic process the course of a phenomenon is seen as a consequence of a number of coincidences governed by the law of probability. To establish the component processes for a given phenomenon the physical mechanism governing it should be known. A model is a more or less simplified physical or mathematical representation of a process. Three types of models are generally used in hydrology: (1) the physical model; (2) the analogue model; and (3) the mathematical model. Hydrological models are used in tracer experiments to allow for a better understanding of phenomena, estimate hydrological parameters, compute the optimal tracer amount needed for the experiment and a sampling schedule, make prognostications concerning the behavior of the system, etc. The three major types of models can be used individually or, possibly, together. There are situations when physical models prove satisfactory, but they are expensive and can model the phenomenon under study on a small space and time scale. Physical models, however, are used to improve mathematical models and pinpoint the importance and size of certain factors, parameters, etc. involved in mathematical models. Analogue models have few applications at present. (See also W89-01981) (Lantz-PTT)
W89-01984

MONTE CARLO METHOD IN RADIOTRACER EXPERIMENTS,
Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
M. Oncescu.
IN: Modern Trends in Tracer Hydrology. Volume I. CRC Press, Inc., Boca Raton, FL. 1987. p 109-138, 11 fig, 6 tab, 21 ref.

Descriptors: *Data interpretation, *Monte Carlo Method, *Radioactive tracers, *Groundwater movement, Tracers, Computer models, Model studies, Flow profiles, Radioactivity, Hydrology.

In radioactive tracer hydrology, two problems appear to be of major importance: (1) in the planning of an experiment with radioactive tracer, the computation of the minimum necessary activity, lambda, of the tracer so that the resulting radioactive concentration, C, can be measured with the available detection assembly; and (2) the choice of the optimum detection assembly able to measure a radioactive concentration, C, natural or manmade. To solve these two problems, one must know the following two characteristics of a detection assembly related to the radioactive concentration: minimum detectable (observable) value, and resolution. In the definitions of these two quantities, there appear some aspects directly related to the operation of a radiation detection assembly: the important role of the statistical fluctuations in the pulse formation, and the electronic instability during the radiation detection process. An application of radioactive tracers was chosen that is often encountered in practice: the monitoring of the motion of water in an aquifer through an underground cavity in a karst, or the passage of an undergraound water through a natural reservoir. In these situations it is necessary that monitored water be traced with a radionuclide. The monitoring of water through the cavity or through the reservoir is performed by measuring over time the concentration of the radioactive tracer in the water. The measurement of radioactive concentration is done with a detector immersed in the volume of the extended radioactive source. In this discussion, the advantages of this measuring geometry is pointed out. For computer simulation by the Monte Carlo method of measuring radioactive concentration in the reservoir, a cylindrical reservoir filled with water was modeled. (See also W89-01981) (Lantz-PTT)
W89-01985

SATELLITE REMOTE SENSING AND ENERGY BALANCE MODELLING FOR WATER BALANCE ASSESSMENT IN (SEMI-) ARID REGIONS,
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
For primary bibliographic entry see Field 7B.
W89-02229

BALSEQ - A MODEL FOR THE ESTIMATING OF WATER BALANCES, INCLUDING AQUIFER RECHARGES, REQUIRING SCARCE HYDROLOGIC DATA,
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
For primary bibliographic entry see Field 2F.
W89-02242

2B. Precipitation

MODELLING PRECIPITATION IN A COLD FRONTAL RAINBAND,
Meteorological Office, Bracknell (England).
G. P. Fox.
Meteorological Magazine MTMGA5, Vol. 117, No. 1392, p 224-228, July 1988. 4 fig, 5 ref.

Descriptors: *Model studies, *Precipitation, *Rainfall, Frontal rainbands, Mathematical models.

The simulation of the narrow cold frontal rainband using the full (mixed-phase) parametrization gave results comparable with field observations. However, the warm microphysics parametrizations gave less realistic distributions of surface precipitation and precipitation concentration aloft. Since melting and loading effects may provide important feedbacks to the dynamics locally, a highly parametrized warm scheme is likely to be inadequate for dynamical models of high resolution. In corresponding results for a weak warm frontal rainband similar conclusions were drawn. In addition, the warm microphysical parametrization did not represent the distribution of latent heat transfer well, particularly at levels where particle melting occurred using the ice phase parametrization. (Sand-PTT)
W89-01344

OBJECTIVE RAINFALL EVALUATION IN RADAR HYDROLOGY,
INTERA Technologies Ltd., Calgary (Alberta).
For primary bibliographic entry see Field 7C.
W89-01368

PRECIPITATION DEVELOPMENT IN NATURAL AND SEEDED CUMULUS CLOUDS IN SOUTHERN AFRICA,
Toronto Univ. (Ontario). Dept. of Physics.
For primary bibliographic entry see Field 3B.
W89-01375

FOG EFFECT OF THE GREAT SALT LAKE,
Utah Water Research Lab., Logan.
G. E. Hill.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 6, p 778-783, June 1988. 10 fig, 4 ref.

Descriptors: *Fog, *Great Salt Lake, *Lake evaporation, Saline lakes, Temperature effects, Weather data collections, Seasonal distribution.

The effect of the Great Salt Lake in the frequency and geographical extent of wintertime fog is analyzed by use of fog reports, precipitation, and temperature records over a 25-yr period, during which time the size of the lake has more than doubled. Fog reports at Salt Lake City on days when precipitation other than snow grains did not occur are analyzed to find a relationship between lake size and fog frequency. While a large winter-to-winter variability is found, there is also a strong relationship with lake size. To analyze the geographical effect of the lake on fog, the daily range of temperature is first related to the occurrence of persistent fog; it is shown that when fog is present throughout a day the difference between the maximum and minimum temperature will be low. Analysis of the geographical distribution of these persistent fog days shows the strong effect of the lake. Also, the occurrence of persistent fog was much less when the lake was small compared to when the lake was large. (Author's abstract)
W89-01376

CLOUD DROPLETS: SOLUTE CONCENTRATION IS SIZE DEPENDENT,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W89-01436

METHODS FOR ESTIMATION OF NATURAL GROUNDWATER RECHARGE DIRECTLY FROM PRECIPITATION - COMPARATIVE STUDIES IN SANDY TILL,
Royal Inst. of Tech., Stockholm (Sweden). Institutionen foer Kulturteknik.
For primary bibliographic entry see Field 2F.
W89-02238

RAINFALL - RUNOFF - RECHARGE RELATIONSHIPS IN THE BASEMENT ROCKS OF ZIMBABWE,
Hydrotechnica, Shrewsbury (England).
J. Houston.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 349-365, 11 fig, 3 tab, 13 ref.

Descriptors: *Groundwater recharge, *Zimbabwe, *Recharge, *Surface-groundwater relations, *Rainfall-runoff relationships, Aquifers, Base flow, Chemical analysis, Rainfall, Runoff, Simulation analysis, Model studies.

The resources of Basement aquifers in Victoria Province, Zimbabwe are largely dependent on rainfall recharge but no direct evidence for recharge in the form of borehole hydrographs is available. Estimates of recharge have been made by three methods: river baseflow analysis; hydrochemical analysis of groundwaters and simulation modelling. All three methods produce consistent results, suggesting that recharge amounts to between 2-5% of annual rainfall. Under such circumstances, which are widespread in Africa, it is essential to make resource estimates based on many years of data, otherwise over or under estimates are likely because of the considerable annual variation in rainfall. (See also W89-02223) (Author's abstract)
W89-02245

SIMPLE ANALYTICAL METHODS FOR ESTIMATING SHORT-TERM RAINFALL,
Army Topographic Command, Washington, DC.
R. L. Wexler.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A183 812. Price codes: A04 in paper copy, A01 in microfiche. Engineer Topographic Laboratory Report No. ETL-0441, November 1986. 55p, 5 fig, 8 tab, 15 ref, 3 append.

Descriptors: *Rainfall forecasting, *Rainfall estimation, *Rainfall, *Model studies, Temperature, Rainfall distribution, Rainfall intensity, Estimating.

Annual hourly rainfall may be estimated at times as a function of mean annual temperature. Instantaneous rainfall is limited in this study to one-hour storms or rainy periods within storms. Two rainfall models are provided. The first, general model, is based mainly on a particular skew distribution that was found previously to represent rainfall under very diverse conditions. This model recovers a considerable range of information for almost any rainfall occurrence. The second, or explicit, model is specific for a given average rain rate. The latter model may be utilized for situations not covered by the general model or as an alternate method. In contrast to certain of the earlier techniques, these models: (a) depend on viable rainfall mass distribution for the situation at hand; and (b) determine short-term rainfall, first with respect to the percent frequency of the total duration of the rain and with respect to real time. The results yield reasonably accurate short-term rain rates for nearly 98% of the rain period. Either model readily determines the percent of time the average rain rate of any selected rain rate is equalled or exceeded. Of significance is the fact that the mean daily, hourly, or instantaneous rain intensity for any duration tends to be greatly exceeded for at least 5% of the time. The graphs and computer programs given not only facilitate the rapid estimation of short-term rainfall for almost any situation, but also serve to improve understanding of short-term rainfall spectra. (Lantz-PTT)
W89-02261

2C. Snow, Ice, and Frost

MODEL FOR INFILTRATION IN FROZEN SOILS THAT ACCOUNTS FOR WATER QUALITY (UN MODELE POUR L'INFILTRATION DANS LES SOLS GELES TENANT COMPTE DE LA QUALITE DE L'EAU),
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec). Centre de l'Energie.
For primary bibliographic entry see Field 2G.
W89-01339

LOSS OF HALIDE AND SULPHATE IONS FROM MELTING ICE,
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-01447

TRACKING TWO-DIMENSIONAL FREEZING FRONT MOVEMENT USING THE COMPLEX VARIABLE BOUNDARY ELEMENT METHOD,
Williamson and Schmid, Irvine, CA.
For primary bibliographic entry see Field 2G.
W89-02266

2D. Evaporation and Transpiration

FOG EFFECT OF THE GREAT SALT LAKE,
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 2B.
W89-01376

EVAPORATION IN ARID AND SEMI-ARID REGIONS,
Agricultural Univ., Wageningen (Netherlands). Dept. of Physics and Meteorology.
H. A. R. de Bruin.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 73-88, 4 fig, 34 ref, append.

Descriptors: *Evaporation, *Arid lands, *Semiarid lands, Meteorology, Precipitation, Model studies, Remote sensing.

Meteorological aspects of evaporation in arid and semi-arid regions are surveyed, including: roughness length and zero plane displacement, stability effects, net radiation, and advection. The main features of existing routine methods are discussed. It is pointed out that most models for evaporation are developed for temperate crops. The main differences between temperate and (semi-)arid regions are related to the differing quantities of precipitation. Special attention is paid to the use of remote sensing techniques, for the determination of evaporation. (See also W89-02223) (Lantz-PTT)
W89-02228

2E. Streamflow and Runoff

ANTARCTIC STREAM ECOSYSTEMS: VARIABILITY IN ENVIRONMENTAL PROPERTIES AND ALGAL COMMUNITY STRUCTURE,
Department of Scientific and Industrial Research, Taupo (New Zealand). Taupo Research Lab.
For primary bibliographic entry see Field 2H.
W89-01274

MULTITABLE ANALYSES IN FACTORIAL ECOLOGY: II. LONGITUDINAL STRATIFICATION OF THE ARDECHE, BEGINNING WITH PHYSICO-CHEMICAL DESCRIPTORS (LES ANALYSES MULTITABLEAUX EN ECOLOGIE FACTORIELLE: II. STRATIFICATION LONGITUDINALE DE L'ARDECHE A PARTIR DE DESCRIPTEURS PHYSICO-CHEMIQUES),
Lyon-1 Univ., Villeurbanne (France).
For primary bibliographic entry see Field 2H.
W89-01293

Group 2E—Streamflow and Runoff

FLOOD INDICES IN FINNISH RIVERS (SUOMEN JOKIEN TULVAINDEKSIT),
Turku Univ. (Finland). Institutum Geographicum.
H. Mansikkaniemi.
Terra, Vol. 98, No. 2, p 126-137, 1986. 5 fig, 3 tab, 11 ref. English summary.

Descriptors: *Floods, *Flood discharge, *Flood data, Rivers, Catchment areas, Finland, Rainfall-runoff relationships.

Indices were developed which describe the severity of floods in Finnish rivers. By means of a general flood index, GFL, and maximum flood index the discharge in the rivers during the floods is compared with the median of monthly discharge. The Finnish rivers studied have a catchment area of at least 600 sq km. Discharge data should also be available from these rivers during the 20-year period 1961-1980. The following rivers of the 36 studied had the most violent floods: Aurajoki, Kuivajoki and Simojoki, where GFL is 20-25. The smallest floods appeared in Vuoksi, Kymijoki, Oulujoki and Paatsjoki, where GFL is 2 or below. The proportion of lake area and the size of the drainage area explains 55 % of the variation in flood index in Finland. This work also shows that the famous floods in southern Ostrobothnia are mainly caused by topographical and morphological features and not by exceptionally large water masses. (Author's abstract)
W89-01311

HYDROLOGIC INFLUENCES ON LEAF DECOMPOSITION IN A CHANNEL AND ADJACENT BANK OF A GALLERY FOREST STREAM,
Kansas State Univ., Manhattan. Dept. of Systematics and Ecology.
For primary bibliographic entry see Field 2H.
W89-01331

USE OF PLASTIC STRIPS TO MEASURE LEAF RETENTION BY RIPARIAN VEGETATION IN A COASTAL OREGON STREAM,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 7B.
W89-01332

MICROHABITAT USE BY THE BIGMOUTH CHUB NOCOMIS PLATYRHYNCHUS IN THE NEW RIVER, WEST VIRGINIA,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
For primary bibliographic entry see Field 2H.
W89-01333

RIVER-BEND CURVATURE AND MIGRATION: HOW ARE THEY RELATED,
Florida State Univ., Tallahassee. Dept. of Geology.
For primary bibliographic entry see Field 2J.
W89-01336

CISTERNS FOR WATER CONSERVATION AND FLOOD CONTROL,
French (R.H.), Las Vegas, NV.
For primary bibliographic entry see Field 4A.
W89-01370

ASSESSING THE RISK OF VIOLATING STREAM WATER QUALITY STANDARDS,
Wyoming Univ., Laramie. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-01373

FACTORS CONTROLLING THE SECONDARY PRODUCTIVITY OF BENTHIC MACROINVERTEBRATES IN FRESHWATERS: A REVIEW, (IN JAPANESE),
National Inst. for Environmental Studies, Ibaraki (Japan). Environmental Biology Div.
For primary bibliographic entry see Field 2H.
W89-01382

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART I,
K. Bedford, A. Findikakis, B. E. Larock, W. Rodi, and R. L. Street.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 114, No. 9, p 970-991, September 1988. 1 fig, 1 tab, append.

Descriptors: *Turbulent flow, *Model studies, *Surface water, *Hydraulic models, Flow, Lakes, Mathematical analysis, Mathematical models, Mathematical equations, Mixing, Water currents, Eddies, Viscosity, Physical properties, Rheology, Stratification.

The structure of turbulence models, their use in various classes of surface water models, the considerations required inselecting or building a turbulence model-based code, and an evaluation of the impact of such models on surface water modeling are documented. Surface water models are considered with both hydraulic engineering and environmental hydraulics applications in mind, and the general model equations for free surface flow and transport are stated for the case of two-dimensional vertically averaged and two-dimensional areally averaged situations as well as the general three-dimensional case. Terms requiring closure are defined and the basic eddy viscosity and diffusivity concept is presented. The various classes of turbulence models are defined and a very brief discussion of constant and mixing length dependent viscosity ensues. The paper concludes with a presentation of the one-equation and general two-equation k-epsilon turbulence model for multidimensional flows. The constants used in the two-equation model are summarized and their universality is discussed. (See W89-01413 thru W89-01416) (Author's abstract)
W89-01412

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART II,
K. Bedford, A. Findikakis, B. E. Larock, W. Rodi, and R. L. Street.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 114, No. 9, p 992- 1014, September 1988. 3 fig, 2 tab.

Descriptors: *Turbulent flow, *Model studies, *Surface water, *Boundary conditions, *Hydraulic models, Flow, Mathematical analysis, Mathematical models, Mathematical equations, Boundaries, Stress, Rheology, Heat flow, Case studies, Powerplants, Nuclear powerplants, Topography.

The two-equation turbulence model for two-dimensional vertically integrated models is discussed. Special attention is placed upon the proper inclusion of bottom generated turbulence in the formulation. An extensive discussion of turbulent stress/flux equations ensues. The Reynolds stress equation is presented as is a detailed discussion of the method for including the effects of pressure on the calculation. Incorporation of wall effects on the pressure/stress calculation is performed by a damping function. A discussion of turbulent scalar flux and variance equation is presented, and pressure and wall effects are again considered. Simplification via algebraic representation of the stress/flux equation is discussed. A particular difficulty in the use of such stress/flux models is the nonavailability of boundary data for the various terms. Various types of boundary condition treatments are summarized including wall and free surface varieties. The paper concludes with the first of three case studies; this one being a heated effluent discharge model of the Bruce A and B nuclear power plants on Lake Huron. Built by G. Raithby, the model is a full 3D formulation with a kappa-epsilon model. (See also W89-01414 thru W89-01416 andu W89-01412) (Author's abstract)
W89-01413

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART III,
K. Bedford, A. Findikakis, B. E. Larock, W. Rodi, and R. L. Street.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 114, No. 9, p 1015- 1033, September 1988. 10 fig, 2 tab, append.

Descriptors: *Turbulent flow, *Model studies, *Surface water, *Path of pollutants, *Solute transport, *Hydraulic models, Flow, Mathematical analysis, Mathematical models, Mathematical equations, Case studies, Mixing, Powerplants, Cooling water, Boundary conditions, Estuaries, Tidal effects, Wind, Salinity, Chemical properties.

Two case studies demonstrate the use of turbulence models in surface water flow computations. The first case study is by W. Rodi and co-workers and summarizes calculations of heated effluent disposal into the Rhine River. A model chain concept is defined for the calculation. The distinctions between the chains are based upon the strength of recirculation in the hot zone and the upstream propagation of pressure effects. Comparisons with data reveal that the strong three-dimensional effects for submerged jets required the full 3D model but that surface jets were adequately modeled by the 2D formulation. The second case study in this paper documents the prediction of flow and salt transport in the Hudson/Raritan River Estuary. A three-dimensional formulation is used, but horizontal diffusion has been neglected as the grid was assumed fine enough to resolve its effects. The level 2.5 turbulence closure developed by Mellor and Yamada is used and is based upon a turbulence length scale as opposed to dissipation. An extensive series of calculations for the Hudson River estuary region is presented. (See also W89-01412, W89-01413 and W89-01415 thru W89-01416) (Author's abstract)
W89-01414

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART V,
K. Bedford, A. Findikakis, B. E. Larock, W. Rodi, and R. L. Street.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 114, No. 9, p 1052- 1073, September 1988. 1 tab, 226 ref, append.

Descriptors: *Turbulent flow, *Model studies, *Surface water, *Hydraulic models, Hydraulics, Reviews, Literature review.

The status of turbulence model-based surface water models was evaluated. Two classes of models are evaluated: hydraulic engineering and environmental hydraulics. A table lists the eight major categories of problems. Also listed are citations for the types of turbulence models used in recent solutions to these problems. From this summary table, a number of subjective impressions are discussed. In general, almost all the relevant problem classes have been performed with some form of advanced turbulence model; however, the hydraulic engineering subclass is the most frequently performed. As positive as this impact is, it has not been the case that practitioners have adopted turbulence models to any great degree. The reason for this skepticism is the lack of objective methods of performance evaluation and the lack of any data taken with sufficient precision to establish the credibility of one turbulence model formulation over another. Creation of a library of high quality data for flow of relevance to hydraulic engineers is suggested. (See W89-01412 thru W89-01415) (Author's abstract)
W89-01416

COMPREHENSIVE METHOD OF CHARACTERISTICS MODELS FOR FLOW SIMULATION,
Geological Survey, Reston, VA.
C. Lai.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 114, No. 9, p 1074-1097, September 1988. 10 fig, 24 ref, 3 append.

Descriptors: *Model studies, *Simulation, *Open-channel flow, Numerical analysis, Field tests, Model testing, Stability analysis.

The use of the specified time interval (STI) numerical schemes has been popular in applying the method of characteristics (MOC) to unsteady open-channel flow problems. Studies and analyses of several variants of the STI schemes have led to

the derivation of a new scheme, referred to herein as the multimode scheme, which combines implicit, temporal reachback, spatial reachback, and classical schemes into one. Three numerical models have been developed to implement the implicit and multimode schemes. The IMOCDS model uses an implicit scheme, with which the time step is no longer subject to the Courant constraint. The remaining two models, NEWMOC and SPRMOC, are two versions of the multimode scheme. The NEWMOC and SPRMOC models demonstrate all the advantages previously provided by individual STI schemes, cover the combined flow range of the various schemes involved, and, in addition, display newly-acquired benefits such as robustness. Numerical analyses, numerical experiments, and field applications that verify, support, and demonstrate the enhanced model capabilities are presented. (Author's abstract)
W89-01417

SEDIMENT-WATER OXYGEN AND NUTRIENT FLUXES IN A RIVER-DOMINATED ESTUARY,
Louisiana State Univ., Baton Rouge. Coastal Ecology Lab.
For primary bibliographic entry see Field 2L.
W89-01422

ESTIMATING THE NET FLUX OF NUTRIENTS BETWEEN A SALT MARSH AND A TIDAL CREEK,
South Carolina Univ., Columbia. Dept. of Statistics.
For primary bibliographic entry see Field 2L.
W89-01423

STUDY ON POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS IN RIVERS AND ESTUARIES IN OSAKA BAY IN JAPAN.
Setsunan Univ., Neyagawa (Japan). Faculty of Pharamaceutical Sciences.
For primary bibliographic entry see Field 5B.
W89-01440

EFFECT OF PROLONGED EXPOSURE TO ACETYLENE ON DENITRIFICATION IN A LABORATORY STREAM SEDIMENT SYSTEM,
Oxford Univ. (England). Dept. of Plant Sciences.
For primary bibliographic entry see Field 7B.
W89-01446

IN-STREAM NITRIFICATION RATE PREDICTION,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-01450

CLIMATOLOGY AND HYDROLOGY,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
For primary bibliographic entry see Field 2A.
W89-01694

STREAMFLOW GENERATION BY VARIABLE SOURCE AREA,
Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab.
A. R. Hibbert, and C. A. Troendle.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 111-127, 14 fig, 2 tab.

Descriptors: *Streamflow, *Model studies, *Mathematical studies, *Rainfall-runoff relationships, *Forest hydrology, Hydrographs, Rainfall, Overland flow, Slopes, Channel flow, Computer models.

Much of the early work that shaped current concepts of streamflow generation on forest lands was done at the Coweeta Hydrologic Laboratory. In 1941, the sources of storm flow on Coweeta Watershed 13 (WS 13), a 16-ha catchment covered by mixed hardwoods was systematically analyzed. Streamflow was perennial, with annual yields similar to larger basins in the region. Characteristic flood hydrographs were produced by heavy rains, even though no overland flow was observed. Two types of storm flow hydrographs were analyzed. The first was produced by a short, intense rainfall of 18 mm in 25 min. Storm flow response was 1.1% of rainfall; all of it passed the gaging station within 2 hr of rainfall. This response was primarily attributed to channel precipitation, rain falling directly on the channel surface, which measured 1.2% of the total catchment area. The second type of hydrograph was from a much larger storm (164 mm in 24 hr). Total storm runoff within 24 hr of rainfall cessation was 14%, even though antecedent flow rate was below the watershed average, a condition that would suggest a lower-than-average response. Again, 1% or more of rainfall was intercepted by the channel, but in this case the bulk of the runoff was attributed to subsurface storm flow, since no overland flow was observed. Further definition of slope processes, hillslope studies, and watershed processes are discussed to determine a variable source area model. The domain of the model is intended to be the first- to second-order forest or wildland catchment. It should include any vegetated catchment outside desert areas, with perennial flow. A first-generation computer program was developed and tested on the Fernow Experimental Forest in West Virginia. Simulations of individual storm hydrographs from the 95-acre forested watershed were quite good. The second-generation model appeared to work reasonably well. Both studies noted that modeling the variable source area is far from complete. (See also W89-01691) (Lantz-PTT)
W89-01699

TROPHIC SIGNIFICANCE OF DISSOLVED ORGANIC CARBON IN STREAMS,
Georgia Univ., Athens. Dept. of Botany.
J. L. Meyer, C. M. Tate, R. T. Edwards, and M. T. Crocker.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 269-278, 5 fig.

Descriptors: *Organic matter, *Organic carbon, *Forest ecology, *Coweeta, *North Carolina, Particulate matter, Forest watersheds, Stream channels, Cycling nutrients.

The dissolved organic carbon (DOC) concentration of Coweeta streamwater is relatively low (< 1.5 mg C/L during baseflow), and is similar to the concentration of particulate organic matter in streamwater at baseflow. DOC export/sq m of undisturbed stream channel (137 to 145 g C/sq m) is slightly less than leaf litter inputs to Coweeta streams. About 15 kg C/ha (watershed area) is low annually from undisturbed Coweeta watersheds as DOC. Hence, DOC export is an important component of organic carbon export from forested watersheds at Coweeta as well as in other regions of the country. The DOC lost from terrestrial ecosystems enters streams. The fate of this DOC, its uptake, and its role in the food web of the stream was examined, and DOC sources (leaching of organic matter), particularly those within the stream channel, are discussed. Also examined is the manner in which streamwater DOC concentration changes as watersheds recover from a disturbance. (See also W89-01691) (Lantz-PTT)
W89-01704

CRITIQUE OF THE INSTREAM FLOW INCREMENTAL METHODOLOGY AND OBSERVATIONS ON FLOW DETERMINATION IN NEW ZEALAND,
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
For primary bibliographic entry see Field 7C.
W89-01738

CONSIDERATIONS IN ASSESSING FLUSHING FLOW NEEDS IN REGULATED STREAM SYSTEMS,
Bechtel, Inc., San Francisco, CA.
D. W. Reiser, M. P. Ramey, and T. R. Lambert.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 45-57, 2 fig, 2 tab, 41 ref.

Descriptors: *Flushing, *Flow profiles, *Regulated flow, *Streamflow, Standards, Ecological effects, Ecology.

Until standard methods are developed for assessing flushing flows, evaluations need to use an approach tailored to the specific needs and characteristics of each stream and project. This may dictate the use of several different office techniques to derive an initial flow estimate, followed by detailed field studies to refine the recommendations. For projects in the planning stage, an office approach may be all that is needed; implementation studies should include detailed field investigations. Recommended guidelines for conducting flow studies include: (1) The utilization of an interdisciplinary team approach; (2) An initial determination of the actual need for the flushing flow should precede detailed assessments; (3) The assessment approach used should be tailored to the specific needs and characteristics of each stream and project; office and field techniques may both be required; (4) For comparison purposes, more than one method should be used for deriving flow recommendations; (5) A determination of the timing and required duration of the flow should be included as part of the assessment process; (6) Flushing flow recommendations should be stated in terms of magnitude, timing and duration; and (7) Follow-up studies should be conducted to evaluate the effectiveness of the flows and allow for necessary adjustments. (See also W89-01736) (Lantz-PTT)
W89-01739

ASSESSMENT OF FLUSHING FLOW RECOMMENDATIONS IN A STEEP, ROUGH, REGULATED TRIBUTARY,
Wyoming Water Research Center, Laramie.
T. A. Wesche, V. R. Hasfurther, W. A. Hubert, and Q. D. Skinner.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 59-69, 5 fig, 1 tab, 15 ref.

Descriptors: *Flushing, *Streamflow, *Flow regulation, *Water quality, *Ecological effects, Sediment load, Runoff, Little Snake River, Mathematical studies.

Alteration of stream flow regime and sediment loading from water development activities can result in both short- and long-term changes in channel morphology and conveyance capacity. Subsequently, the condition of the aquatic habitat can be affected. Three spring runoff flushes meeting or exceeding the magnitude and duration of the recommended flushing flow for the studied section of the North Fork of the Little Snake River were somewhat successful in reducing the quantity of deposited material. Flushing was more effective in steeper gradient reaches, while results regarding duration of the individual flushes are at present inconclusive. As indicated by the Fredle Index, quality of the deposited material was very low throughout the study area. Quality of deposited material showed an improving trend in response to the runoff hydrograph within the study reaches having the largest quantities of deposition. (See also W89-01736) (Lantz-PTT)
W89-01740

SIMULATING TROUT FEEDING STATIONS IN INSTREAM FLOW MODELS,
Washington State Dept. of Game, Olympia.
For primary bibliographic entry see Field 2H.
W89-01741

EFFECTS OF VARYING FLOWS IN MAN-MADE STREAMS ON RAINBOW TROUT (SALMO GAIRDNERI RICHARDSON) FRY,
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W89-01742

DEVELOPMENT AND APPLICATIONS OF MACROINVERTEBRATE INSTREAM FLOW MODELS FOR REGULATED FLOW MANAGEMENT,
Tulsa Univ., OK. Faculty of Biological Science.
For primary bibliographic entry see Field 4A.
W89-01743

STONEFLIES AND RIVER REGULATION - A REVIEW,
Oslo Univ. (Norway). Zoological Museum.
For primary bibliographic entry see Field 2H.
W89-01744

HYDROPOWER DEVELOPMENT OF SALMON RIVERS: EFFECT OF CHANGES IN WATER TEMPERATURE ON GROWTH OF BROWN TROUT (SALMO TRUTTA) PRESMOLTS,
Direktoratet for Vilt og Ferskvannsfisk, Trondheim (Norway).
For primary bibliographic entry see Field 6G.
W89-01749

PREDICTING THE EFFECTS OF A POSSIBLE TEMPERATURE INCREASE DUE TO STREAM REGULATION ON THE EGGS OF WHITEFISH (COREGONUS LAV ARETUS) - A LABORATORY APPROACH,
Oslo Univ. (Norway). Zoological Museum.
For primary bibliographic entry see Field 5C.
W89-01750

NATURAL SILTATION OF BROWN TROUT (SALMO TRUTTA L.) SPAWNING GRAVELS DURING LOW-FLOW CONDITIONS,
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 2J.
W89-01751

SUSPENDED SOLIDS TRANSPORT WITHIN REGULATED RIVERS EXPERIENCING PERIODIC RESERVOIR RELEASES,
Loughborough Univ. of Technology (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W89-01752

TIME-SCALES FOR ECOLOGICAL CHANGE IN REGULATED RIVERS,
Loughborough Univ. of Technology (England). Dept. of Geography.
G. E. Petts.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 257-266, 4 fig, 3 tab, 15 ref.

Descriptors: *Ecological effects, *Classification, *Regulated flow, *Rivers, Streamflow, Model studies, Spatial variation, Flow profiles, Ecosystems.

A Transient System Model is described, which uses a hierarchical system structure and location-for-time substitution, to provide a framework for the consideration of spatial patterns of change along regulated rivers within an appropriate time-scale. River channel compartments, defined by a particular combination of micro-habitats, represents a temporal sequence of system states. Within two British rivers, three compartments have been identified: adjusted, changing and stable. The latter two compartments, representing transient system states, have been identified within both rivers using physical and biological criteria. Stable compartments typically have a higher invertebrate density than the other compartments. The changing compartments of both rivers have been divided into sites of gravel-bed sedimentation and aggrading sites dominated by fine minerogenic and organic sediments. Some components of the river system will respond to flow regulation more readily than others, and some locations will readjust at a faster rate. In changing fluvial systems the continua describing downstream variations of individual parameters are characterized by discontinuities associated, not least, with tributary confluences. Consequently, the downstream pattern of change can relate to the structure of the drainage network. The conceptual model presented demonstrates that at any point in time, different parts of the regulated river can be in different phases of readjustment and that at a single location the biotic communities may experience a complex sequence of changes during the readjustment period. For the regulated coarse-gravel-bed rivers of Britain, a time-scale measured in tens of years is required for the assessment of third-order ecological change. (See also W89-01736) (Lantz-PTT)
W89-01753

TOWARDS A RATIONAL ASSESSMENT OF RESIDUAL FLOWS BELOW RESERVOIRS,
Institute of Hydrology, Wallingford (England).
A. Gustard, and G. A. Cole.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 267-275, 7 fig, 8 ref..

Descriptors: *Rivers, *Streamflow, *Regulated flow, *Reservoirs, Seasonal variation, Ecological effects, Hydrology.

Flow changes are an inevitable result of the primary function of a reservoir; to store water in periods of surplus and release to the consumer or river in times of deficiency. Many compensation flows were awarded at a time when there was little understanding of differences in catchment hydrology, and most occurred at a time when there was no knowledge of the impact of impoundments on downstream fauna and flora. This would suggest that a review of current releases below reservoirs is warranted. Pressures to increase downstream flows would in the long term have to be met by additional water resource schemes where environmental disbenefits may far outweight the advantages of changing the flow pattern of an already regulated stream. The historical development of setting residual flows has resulted in many reservoirs providing releases determined by industrial and political constraints which no longer apply. The average of these statutory minimum discharges is close to the natural low flow but there are wide departures from this trend. Any reassessment of residual flows could initially focus on these anomalous sites. Although the yield and storage capacities of existing reservoirs will provide a major constraint on the freedom to manipulate downstream flows, the water resource engineer will be looking for guidance from the freshwater biologist particularly for setting the seasonal variability of low flows. It will then be necessary to compare any change in reservoir yield with expected improvements or degradation of downstream ecology. (See also W89-01736) (Lantz-PTT)
W89-01754

STUDY DESIGN FOR FISHERIES AND HYDROLOGY ASSESSMENT IN A GLACIAL WATERSHED IN BRITISH COLUMBIA,
British Columbia Hydro and Power Authority, Vancouver.
For primary bibliographic entry see Field 2H.
W89-01756

PHOSPHORUS SPIRALLING IN RIVERS AND RIVER-RESERVOIR SYSTEMS: IMPLICATIONS OF A MODEL,
Academy of Natural Sciences of Philadelphia, Avondale, PA. Stroud Water Research Center.
For primary bibliographic entry see Field 2H.
W89-01757

TRADEOFFS BETWEEN STREAM REGULATION AND POINT SOURCE TREATMENTS IN COST-EFFECTIVE WATER QUALITY MANAGEMENT,
Tennessee Valley Authority, Norris. Water Systems Development Branch.
For primary bibliographic entry see Field 5G.
W89-01758

INCREASING THE OXYGEN CONTENT OF THE KALAJOKI RIVER,
National Board of Waters, Helsinki (Finland).
For primary bibliographic entry see Field 5G.
W89-01760

POSSIBLE EFFECTS OF THE PROPOSED EASTERN ROUTE DIVERSION OF CHANGJIANG (YANGTZE) RIVER WATER TO THE NORTHERN PROVINCES WITH EMPHASIS ON THE HYDROBIOLOGICAL ENVIRONMENT OF THE MAIN WATER BODIES ALONG THE TRANSFER ROUTE,
Academia Sinica, Lochiaschan (China). Inst. of Hydrobiology.
For primary bibliographic entry see Field 6G.
W89-01761

CHEMICAL AND BIOLOGICAL CHANGES IN THE TER RIVER INDUCED BY A SERIES OF RESERVOIRS,
Barcelona Univ. (Spain). Dept. de Ecologia.
For primary bibliographic entry see Field 6G.
W89-01762

RESPONSES OF EPILITHIC ALGAE TO REGULATION OF ROCKY MOUNTAIN STREAMS,
Colorado State Univ., Fort Collins. Dept. of Botany and Plant Pathology.
For primary bibliographic entry see Field 6G.
W89-01763

ECOLOGY OF REGULATED STREAMS: PAST ACCOMPLISHMENTS AND DIRECTIONS FOR FUTURE RESEARCH,
Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
For primary bibliographic entry see Field 6G.
W89-01764

COMPARISONS OF THE PROCESSING OF ELEMENTS BY ECOSYSTEMS, II: METALS,
Marine Biological Lab., Woods Hole, MA.
For primary bibliographic entry see Field 5D.
W89-01837

WILD AND SCENIC RIVERS: CONSERVATION AND NATURAL WATER AMENITIES,
Ministry of Works and Development, Wellington (New Zealand).
For primary bibliographic entry see Field 6F.
W89-01877

ECOLOGICAL PARAMETERS INFLUENCING AQUATIC PLANT GROWTH,
E. O. Gangstad.
IN: Environmental Management of Water Projects. CRC Press, Inc., Boca Raton, FL. 1987. p 49-61, 4 tab, 22 ref.

Descriptors: *Aquatic plants, *Ecosystems, *Agricultural runoff, *Water pollution effects, *Canals, Nutrients, Herbicides, Algicides, Diatoms, Macroinvertebrates, Canals, Aquatic weeds, Productivity, Photosynthesis, Water chemistry.

The management of submersed plants in relation to human activities is confounded by a spectrum of problems associated with many variables such as the soil types (including aquasoils), the nature of the aquatic system (lake, stream, estuary, etc.), and the nature, time, and duration of activity generating pollution. Diatom and macroinvertebrate animal populations were sampled in four irrigation canals to determine effects of herbicide-algicide treatments on nontarget organisms. Results show few statistically significant differences between treated and untreated canals. Canal water return flows were similar to populations occurring in receiving streams. Conclusions support hypotheses that taxa diversity of these organisms can be used to indicate ecological conditions of aquatic canal and river habitats. Field measurements of ecological factors that relate to growth and development of submersed aquatic weeds in irrigation canals

were made on multiple sites, involving 11 canals in Colorado, California, and Washington, from 1959 through 1974. Numerous chemical and physical characteristics of canal water and canal hydrosoil were monitored along with several biological parameters, which included aquatic plant community structure, density, net productivity, and photosynthetic carbon fixation rate. Canal soil microorganisms, phytoplankton, and macroinvertebrate populations were also included in the survey. The only statistically significant differences that were found between canals with and those without aquatic weed infestations involved water chemistry. Canals without aquatic weeds were found to have 70% less available nitrate nitrogen and 40% less total dissolved solids. (See also W89-01990) (Lantz-PTT)
W89-01994

BIOLOGICAL PARAMETERS INFLUENCING GROWTH AND REPRODUCTION OF HYDRILLA,
Environmental Protection Agency, Washington, DC.
R. A. Stanley, and E. O. Gangstad.
IN: Environmental Management of Water Projects. CRC Press, Inc., Boca Raton, FL. 1987. p 63-70, 23 ref.

Descriptors: *Rivers, *Lakes, *Canals, *Hydrilla, *Aquatic plants, *Biological studies, *Aquatic weed control, Aquatic weeds, Ecosystems, Hydrogen ion concentration, Alkalinity, Nutrients, Water temperature, Herbicides.

Hydrilla verticillata Royle (Hydrilla), a monocotyledon, considered to be monotypic in the family Hydrocharitaceae, is an exotic submersed aquatic plant occurring in the U.S. It was first discovered as a U.S. infestation in Florida in 1960, and was apparently introduced from Southeast Asia. Since 1960, it has spread to widely separated locations across North America and has reached problem levels in most waterbodies where it has become established. Its broad ecological variability has enabled it to thrive in riverine and lacustrine environments in the southeastern U.S. and in irrigation and drainage canals in California. It can withstand variations in pH, alkalinity, and nutrient levels, and thrives at water temperatures above 17 C. Its salinity limit is about 12 to 15 ppt. It has the potential for establishment throughout the U.S. It is able to dominate an entire body of water rapidly through a variety of very efficient means of reproduction. At present, there are no known methods for complete eradication of this plant. There are no known natural enemies in the U.S. and biological control are still in the experimental stage. Mechanical methods have proved both costly and ineffective. Chemical herbicides have proved to be the primary tool for management of this aquatic nuisance at this time. (See also W89-01990) (Lantz-PTT)
W89-01995

U.S. ENVIRONMENTAL PROTECTION AGENCY RIVER REACH FILE: HYDROLOGIC SEGMENT PLOTS - WASHINGTON.
Bonneville Power Administration, Portland, OR. Div. of Power Resources Planning.
For primary bibliographic entry see Field 7C.
W89-02003

U.S. ENVIRONMENTAL PROTECTION AGENCY RIVER REACH FILE: HYDROLOGIC SEGMENT PLOTS - OREGON.
Bonneville Power Administration, Portland, OR. Div. of Power Resources Planning.
For primary bibliographic entry see Field 7C.
W89-02004

U.S. ENVIRONMENTAL PROTECTION AGENCY RIVER REACH FILE: HYDROLOGIC SEGMENT PLOTS - MONTANA.
Bonneville Power Administration, Portland, OR. Div. of Power Resources Planning.
For primary bibliographic entry see Field 7C.
W89-02005

UNEXPECTED FACTOR AFFECTING RECHARGE FROM EPHEMERAL RIVER FLOWS IN SWA/NAMIBIA,
Department of Water Affairs, Windhoek (Namibia).
For primary bibliographic entry see Field 2F.
W89-02225

RAINFALL - RUNOFF - RECHARGE RELATIONSHIPS IN THE BASEMENT ROCKS OF ZIMBABWE,
Hydrotechnica, Shrewsbury (England).
For primary bibliographic entry see Field 2B.
W89-02245

2F. Groundwater

LEACHING OF CARBOFURAN IN FLOODED FIELD UNDER PUDDLED AND NONPUDDLED CONDITIONS,
Central Rice Research Inst., Cuttack (India). Lab. of Soil Microbiology.
For primary bibliographic entry see Field 5B.
W89-01283

NITRATE CONTENT IN FRACTURE ZONE GROUNDWATER IN THE HUMID TROPICS AS RELATED TO DEFORESTATION (LA TENEUR EN NITRATES DES NPPES DE FSSURES DE LA ZONE TROPICALE HUMIDE EN RELATION AVEC LES PROBLEMES DE DEFORESTATION),
Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
For primary bibliographic entry see Field 4C.
W89-01309

IRRIGATION RELATED ARSENIC CONTAMINATION OF A THIN, ALLUVIAL AQUIFER, MADISON RIVER VALLEY, MONTANA, U.S.A.
Montana Bureau of Mines and Geology, Butte.
For primary bibliographic entry see Field 5B.
W89-01316

EFFECT OF THE ENVIRONMENT ON THE HYDROCHEMICAL CHARACTERISTICS OF AN ALLUVIAL AQUIFER FOLLOWING AN EXCEPTIONAL MULTIYEAR DROUGHT (MEDITERRANEAN SEASHORE, HERAULT, FRANCE): PART I. RECHARGE OF THE AQUIFER,
Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
J.-C. Grillot, I. Chaffaut, and M. Razack.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 2, p 163-173, April 1988. 8 fig, 18 ref.

Descriptors: *France, *Aquifers, *Alluvial aquifers, *Drought, *Karst hydrology, *Groundwater recharge, Sulfates, Nitrates, Chlorides, Permeability, Manure fertilizers, Mediterranean seashore.

The hydrochemical evolution of an alluvial aquifer is analyzed during a water rising occurring after a five-year drought and according to its recharge modalities (recharge from the surface and from a lateral karst bordering the upper part of the aquifer). A study of the transfer of some elements (chloride, sulfate, nitrate) from the surface (agricultural manures and treatments) and from the karst, illustrates that transfer times should be interpreted with respect to the permeability variations of the alluvial system, including its overburden. As a consequence, the homogenization of the dilutions at the scale of the aquifer and local dissolutions within a pervious zone of the aquifer would be related to the variations of the permeability and to the geochemical heterogeneities of the aquifer. (See also W89-01318) (Author's abstract)
W89-01317

EFFECT OF THE ENVIRONMENT ON THE HYDROCHEMICAL CHARACTERISTICS OF AN ALLUVIAL AQUIFER FOLLOWING AN EXCEPTIONAL MULTIYEAR DROUGHT (MEDITERRANEAN SEASHORE, HERAULT, FRANCE): PART II. CLIMATOLOGY AND AGRONOMY,
Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
J.-C. Grillot, I. Chaffaut, and M. Razack.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 2, p 175-181, April 1988. 3 fig, 13 ref.

Descriptors: *France, *Water quality, *Water pollution sources, *Alluvial aquifers, *Drought, *Groundwater recharge, Sulfates, Nitrates, Chlorides, Potassium, Permeability, Clay, Chemical fertilizers, Agronomy, Mediterranean seashore, Aquifers, Climatology, Soil saturation.

The hydrochemical evolution of an alluvial groundwater located along the Mediterranean seashore is analyzed with respect to its agricultural and climatic environment, including degree of saturation of the soil; types of culture, chemical fertilizers and phytosanitary treatments; selective irrigation of the cultivated areas; precipitation. It is shown that the environmental effect on the groundwater's vulnerability depends on two groups of factors: (1) Transfers from surface to groundwater of nitrates, chlorides, sulfates, and potassium, which are governed by: (a) the climatic conditions before the agricultural activities begin, (b) the kinds of agricultural activities and their distribution in time with respect to a given climatic context. Phenomena of retention and/or rapid diffusion are related to the sedimentary heterogeneities of the reservoir and to the differences of temperatures between irrigation waters and precipitation. (2) Cationic exchanges related to the presence of clays of montmorillonite-kaolinite type. (See also W89-01317) (Author's abstract)
W89-01318

ORGANIC CATION EFFECTS ON THE SORPTION OF METALS AND NEUTRAL ORGANIC COMPOUNDS ON AQUIFER MATERIAL,
Robert S. Kerr Environmental Research Lab., Ada, OK.
For primary bibliographic entry see Field 5B.
W89-01328

GROUNDWATER QUALITY BENEATH THE CITY OF LONDON: OVERVIEW AND LONG-TERM CHANGES,
For primary bibliographic entry see Field 5B.
W89-01353

LARGE-TIME SATURATED-UNSATURATED WATER AND CONTAMINANT TRANSPORT MODEL IN UNCONFINED AQUIFERS,
Australian Inst. of Nuclear Science and Engineering, Sutherland.
For primary bibliographic entry see Field 5B.
W89-01360

SPATIAL CORRELATION OF HYDROLOGIC TIME SERIES,
Miami Univ., Coral Gables, FL. Dept. of Civil and Architectural Engineering.
For primary bibliographic entry see Field 7C.
W89-01371

TRANSPORT AND TRANSFORMATIONS OF ORGANIC CHEMICALS IN THE SOIL-AIR-WATER ECOSYSTEM,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
W. A. Jury, A. M. Winer, W. F. Spencer, and D. D. Focht.
Reviews of Environmental Contamination and Toxicology, Vol. 99, p 119-164, 1987. 10 tab, 119 ref, append.

Descriptors: *Fate of pollutants, *Path of pollutants, *Soil contamination, *Leaching, *Organic compounds, *Water pollution sources, *Air pollu-

tion sources, Groundwater pollution, Biodegradation, Literature reviews, Leaching, Volatility.

The fundamental processes governing the fate of a chemical applied to, or present in, the soil at time zero are discussed. The discussion covers both leaching and biodegradation processes in soil, volatilization of chemicals from soil to atmosphere, and subsequent atmospheric transport and reactions. Downward transport or leaching of dissolved organic chemicals in soil depends principally on the amount of water moving through the system and on the adsorption characteristics of the chemical. Chemical volatilization from soil surfaces is limited both by the vapor density at the soil surface and by the rate of movement to the surface. Once an organic chemical has reached the atmosphere, its persistence depends on the extent of removal by wet and dry deposition and by chemical reactions. Recent observations of chemical concentrations have found widespread dissemination of organic chemicals throughout the remote locations of the Earth, indicating both a substantial amplitude for entering the atmosphere and also considerable atmospheric lifetimes under certain conditions. Chemical biodegradation under field conditions is very poorly understood, both because of the lack of in situ field studies and because the biodegradation process is extremely difficult to isolate from other chemical loss processes such as leaching and volatilization. In the concluding part of this article, a screening model is used to study the relative leaching and volatilization characteristics of 22 pesticide chemicals, showing for leaching the important interactions between mobility and degradation in determining chemicals with the most potential for reaching groundwater. (VerNooy-PTT)
W89-01384

FORCED-GRADIENT TRACER TESTS AND INFERRED HYDRAULIC CONDUCTIVITY DISTRIBUTIONS AT THE MOBILE SITE,
Auburn Univ., AL. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-01402

DETERMINING THE DISTRIBUTION OF HYDRAULIC CONDUCTIVITY IN A FRACTURED LIMESTONE AQUIFER BY SIMULTANEOUS INJECTION AND GEOPHYSICAL LOGGING,
Geological Survey, Denver, CO.
R. H. Morin, A. E. Hess, and F. L. Paillet.
Ground Water GRWAAR, Vol. 26, No. 5, p 587-595, September-October 1988. 4 fig, 25 ref.

Descriptors: *Tracers, *Borehole geophysics, *Geohydrology, *Hydraulic conductivity, *Limestone, *Logging (Recording), Aquifers, Injection, Groundwater hydraulics, Geophysics, Recharge, Vertical distribution, Boreholes, Geologic fractures, Transmissivity, Flow, Turbulent flow, Friction, Hydraulics.

A field technique for assessing the vertical distribution of hydraulic conductivity in an aquifer was applied to a fractured carbonate formation in southeastern Nevada. The technique combines the simultaneous use of fluid injection and geophysical logging to measure in situ vertical distributions of fluid velocity and hydraulic head down the borehole; these data subsequently are analyzed to arrive at quantitative estimates of hydraulic conductivity across discrete intervals in the aquifer. Results identified the contact margin between the Anchor and Dawn Members of the Monte Cristo Limestone as being the dominant transmissive unit. This section is extensively fractured, and quantitative estimates of its hydraulic conductivity are at least two orders of magnitude larger than that of the surrounding competent rock matrix. This transmissive zone also correlates strongly with an interval where the drilling rate was reported to be quite rapid. Aquifer transmissivity was computed from the profile of hydraulic conductivity and found to be 760,000 sq ft/day. The friction factor, a parameter derived from the differential pressure and velocity logs, appears to be a good indicator of borehole rugosity across intervals where fluid velocity remains virtually unchanged, and vertical flow is turbulent. (Author's abstract)
W89-01404

INTERPRETATION OF WELL AND FIELD DATA IN A HETEROGENEOUS LAYERED AQUIFER SETTING, APPALACHIAN PLATEAU,
Northern Illinois Univ., De Kalb. Dept. of Geology.
C. J. Booth.
Ground Water GRWAAR, Vol. 26, No. 5, p 596-606, September-October 1988. 6 fig, 5 tab, 14 ref, append.

Descriptors: *Geohydrology, *Data interpretation, *Groundwater movement, *Well yield, *Aquifers, *Springs, Hydraulic properties, Well hydraulics, Stream discharge, Wells, Water level, Pumping tests, Topography, Streams, Water yield, Sandstones, Appalachian Plateau, Aquitards, Geologic formations, Flow system, Flow, Stratified flow, Seepage.

Groundwater flow systems in the Appalachian Plateau coalfield balance the conflicting controls of topographic relief and hydrostratigraphic layering. Appropriate use of field observations (springs, streams) and abundant domestic-well information (water levels, pumping test results, records of yield, and water-producing zones) helped resolve ambiguities about a typical system in Cambria County, PA. The effective scale for hydrostratigraphic division is by sandstone-dominated members as aquifers and intervening shale-clay members as aquitards. The flow system is stratified in the intervalley ridges; heads, controlled primarily by the dissected aquifer outcrop, drop discretely to lower aquifers. Discrete groundwater discharge and lateral head changes indicate local heterogeneity, enhanced by mine-subsidence effects. The principal valleys carry a topographically controlled system, for which they serve as recharge feeders. (Author's abstract)
W89-01405

HYDROGEOLOGY OF CLAY TILL IN A PRAIRIE REGION OF CANADA,
Department of Agriculture, Lethbridge (Alberta). Groundwater Section.
M. J. Hendry.
Ground Water GRWAAR, Vol. 26, No. 5, p 607-614, September-October 1988. 4 fig, 1 tab, 23 ref.

Descriptors: *Geohydrology, *Clays, *Prairies, *Canada, *Isotope studies, *Glacial soils, Soil types, Radioisotopes, Tritium, Heavy water, Groundwater, Groundwater discharge, Hydraulic conductivity, Seepage, Recharge, Deuterium, Oxygen isotopes.

Hydrogeologic and isotopic investigations were conducted on thick profiles of clayey glacial till at three study areas in the Interior Plains Region of southern Alberta, Canada. The till consists of an upper weathered zone (9 to 18 m thick) and a lower nonweathered zone (10 to 30 m thick). The presence of tritiated groundwater at depths of up to 5 m below the water table in the weathered zone is hydrogeologically active. Interpretation of hydraulic head and hydraulic conductivity data indicates that vertical seepage velocities in the nonweathered till zones range from 2 to 6 m per 1,000 years. Calculated lateral groundwater velocities in the till zones are only about 9 m per 1,000 years, and it is concluded that most of the groundwater recharging the weathered till zone is returned to the atmosphere by evapotranspiration. Oxygen-18 and deuterium analyses of groundwater samples for the weathered till zones support this conclusion. (Author's abstract)
W89-01406

DIMENSIONLESS TIME-DRAWDOWN PLOTS OF LATE AQUIFER TEST DATA,
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Hydrogeology.
Z. Sen.
Ground Water GRWAAR, Vol. 26, No. 5, p 615-618, September-October 1988. 3 fig, 2 tab, 9 ref.

Descriptors: *Drawdown, *Aquifer testing, *Mathematical analysis, *Data interpretation, *Geohydrology, Mathematical equations.

The Jacob straight-line method is concerned with the late time Theis type curve. The Jacob method gives a straight line on semilogarithmic paper. In practice, the Jacob straight line is taken for granted by groundwater hydrologists, hydrogeologists, and engineers, and applied almost universally. Not every straight line on semilogarithmic paper, however, warrants the application of the Jacob method. The Jacob straight-line method has physical restrictions (in addition to the mathematical requirements of having the dimensionless time factor, u, less than 0.01) which are ignored. Therefore, determination of the storage coefficient and transmissivity from the semilogarithmic plot of data yields either over- or underestimations. The objective of this paper is to show that the slope of the straight line on semilogarithmic paper can provide useful quantitative information for the proper application of the Jacob method. Differences in the slopes of the theoretical and field lines implies various physical circumstances. In practice, the Jacob method must be used with great care. The physical construction of the aquifer and flow conditions must be considered. (Author's abstract)
W89-01407

NUMERICAL MODELING OF SALT-WATER INTRUSION AT HALLANDALE, FLORIDA,
GeoTrans, Inc., Herndon, VA.
P. F. Andersen, J. W. Mercer, and J. O. White.
Ground Water GRWAAR, Vol. 26, No. 5, p 619-630, September-October 1988. 9 fig, 2 tab, 18 ref.

Descriptors: *Coastal aquifers, *Mathematical models, *Hallandale, *Florida, *Saline water intrusion, *Geohydrology, Groundwater, Model studies, Chlorides, Wells, Rainfall, Pumpage, Water table rise, Flow system, Water level, Hydraulics, Numerical analysis, Path of pollutants, Model studies.

A series of three numerical models was used to characterize salt-water intrusion at Hallandale, located on the east coast of Florida. A cross-sectional model was used to conceptualize the flow system, and a regional model synthesized input for the third model, the wellfield model. The wellfield model was eventually used to assess the relative merits of proposed water management alternatives. Although the modeling did not isolate a specific cause of the intrusion, it did show the extreme sensitivity of the hydrologic system. Long-term water-level declines of only a few tenths of a foot were shown to result in a significant movement of the salt-water front. There is a distinct time lag, however, between lowering of the hydraulic heads and movement of the salt-water front, which has many implications for water management decisions and in the construction and calibration of a numerical model. These observations, as well as others made in the course of this study, can be applied generally to coastal water management programs. (Author's abstract)
W89-01408

SIMULATION AND PARAMETER IDENTIFICATION OF MASS TRANSPORT IN GROUND WATER,
Bergakademie Freiberg (German D.R.).
F. Hafner, and M. Schwan.
Ground Water GRWAAR, Vol. 26, No. 5, p 631-637, September-October 1988. 6 fig, 2 tab, 19 ref, append.

Descriptors: *Path of pollutants, *Simulation analysis, *Solute transport, *Mathematical models, *Geohydrology, *Groundwater, *Simulation, Convection, Stagnant water, Precipitation, Recharge, Groundwater recharge, Model studies, Numerical analysis.

The transport of solute components in groundwater takes place under the effects of convection, dispersion, and interactions between the stagnant water phase and the solid matrix. The inflow of solutes occurs in the form of local or diffuse sources. Among these, areal sources (precipitation) possess special importance in the recharging of groundwater. Today, simulation of the process with multidimensional models is possible only with

numerical methods. Since convective transport predominates in many cases, a one-dimensional simulation scheme along the flow path is suited to personal computers. This scheme represents the basis for the identification of migration parameters (inverse mass transport problem). (Author's abstract)
W89-01409

THREE-DIMENSIONAL, CROSS-SEMIVARIOGRAM CALCULATIONS FOR HYDROGEOLOGICAL DATA,
Oregon State Univ., Corvallis. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 7C.
W89-01410

INTERPRETATION OF TIDALLY AFFECTED GROUND-WATER FLOW SYSTEMS IN POLLUTION STUDIES,
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-01535

OPTIMIZING RECOVERY OF CONTAMINANT RESIDUALS BY PULSED OPERATION OF HYDRAULICALLY DEPENDENT REMEDIATIONS,
Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5G.
W89-01537

ELECTRO-OSMOTIC REMOVAL OF BENZENE FROM A WATER SATURATED CLAY,
Jordon (E.C.) Co., Wakefield, MA.
For primary bibliographic entry see Field 5G.
W89-01538

NITRATE REMEDIATION OF GASOLINE CONTAMINATED GROUND WATERS: RESULTS OF A CONTROLLED FIELD EXPERIMENT,
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 5G.
W89-01539

ENHANCED BIORECLAMATION, SOIL VENTING AND GROUND-WATER EXTRACTION: A COST-EFFECTIVENESS AND FEASIBILITY COMPARISON,
EA Engineering, Science, and Technology, Inc., Lafayette, CA.
For primary bibliographic entry see Field 5G.
W89-01540

APPLICABILITY OF IN-SITU BIORECLAMATION AS A REMEDIAL ACTION ALTERNATIVE,
Biosystems, Inc., Chester, PA.
For primary bibliographic entry see Field 5G.
W89-01541

BIODEGRADATION OF CHLORINATED CHEMICALS IN GROUNDWATER BY METHANE OXIDIZING BACTERIA,
Cambridge Analytical Associates, Inc., Boston, MA. Bioremediation Systems Div.
For primary bibliographic entry see Field 5G.
W89-01542

DETERMINATION OF A REALISTIC ESTIMATE OF THE ACTUAL FORMATION PRODUCT THICKNESS USING MONITOR WELLS: A FIELD BAILOUT TEST,
S and ME, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5B.
W89-01544

INSTALLATION OF HYDROCARBON DETECTION WELLS AND VOLUMETRIC CALCULATIONS WITHIN A CONFINED AQUIFER: A CASE STUDY,
Engineering Enterprises, Inc., Norman, OK.
For primary bibliographic entry see Field 7A.
W89-01545

GROUND WATER MONITORING EXPERIENCE AT A REFINERY LAND TREATMENT UNIT,
Total Petroleum, Inc., Ardmore, OK.
For primary bibliographic entry see Field 7A.
W89-01546

DETECTION AND DELINEATION OF A FUEL OIL PLUME IN A LAYERED BEDROCK DEPOSIT,
TRC Environmental Consultants, Inc., Englewood, CO.
For primary bibliographic entry see Field 7A.
W89-01547

USE OF HEADSPACE SAMPLING TECHNIQUES IN THE FIELD TO QUANTIFY LEVELS OF GASOLINE CONTAMINATION IN SOIL AND GROUND WATER,
Connecticut Univ., Storrs. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W89-01548

HYDROCARBON VAPOR PLUME DEFINITION USING AMBIENT TEMPERATURE HEADSPACE ANALYSIS,
ERT, A Resource Engineering Co., Fort Collins, Co.
For primary bibliographic entry see Field 5A.
W89-01549

SOIL GAS ANALYSIS OF METHANE AND CARBON DIOXIDE: DELINEATING AND MONITORING PETROLEUM HYDROCARBONS,
For primary bibliographic entry see Field 5A.
W89-01552

LABORATORY SETUP TO STUDY TWO-DIMENSIONAL MULTIPHASE FLOW IN POROUS MEDIA,
American Society for Engineering Education, Washington, DC.
For primary bibliographic entry see Field 5B.
W89-01553

DISSOLUTION OF RESIDUAL DENSE NON-AQUEOUS PHASE LIQUID (DNAPL) FROM A SATURATED POROUS MEDIUM,
Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5B.
W89-01555

EFFECTS OF DISSOLVED OXYGEN ON THE BIODEGRADATION OF BTX IN A SANDY AQUIFER,
Shell Development Co., Houston, TX.
For primary bibliographic entry see Field 5B.
W89-01557

NUMERICAL MODELING OF SUBSURFACE CONTAMINANT TRANSPORT WITH BIODEGRADATION KINETICS,
Rice Univ., Houston, TX. Dept. of Mathematical Sciences.
For primary bibliographic entry see Field 5B.
W89-01558

MASS TRANSFER OF ORGANICS BETWEEN SOIL, WATER AND VAPOR PHASES: IMPLICATIONS FOR MONITORING, BIODEGRADATION AND REMEDIATION,
Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5B.
W89-01559

DEVELOPMENT AND APPLICATION OF A GROUND WATER MODELING DATABASE AND EXPERT SYSTEM,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 7C.
W89-01563

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON SUBSURFACE INJECTION OF LIQUID WASTES.
For primary bibliographic entry see Field 5E.
W89-01564

DEEPER PROBLEMS: LIMITS TO UNDERGROUND INJECTION AS A HAZARDOUS WASTE DISPOSAL METHOD,
Natural Resources Defense Council, Inc., New York.
For primary bibliographic entry see Field 5E.
W89-01565

UNDERGROUND INJECTION: A POSITIVE ADVOCATE,
National Water Well Association, Dublin, OH.
For primary bibliographic entry see Field 5E.
W89-01566

FACTORS EFFECTING THE AREA OF REVIEW FOR HAZARDOUS WASTE DISPOSAL WELLS,
Davis (Ken E.) Associates, Houston, TX.
For primary bibliographic entry see Field 5E.
W89-01572

SIXTEEN SUCCESSFUL YEARS: A HISTORY OF STAUFFER CHEMICAL COMPANY'S UNDERGROUND INJECTION AT BUCKS, ALABAMA,
Joiner (Tom) and Associates, Tuscaloosa, AL.
For primary bibliographic entry see Field 5E.
W89-01576

TWO DECADES OF SUCCESSFUL HAZARDOUS WASTE DISPOSAL WELL OPERATION: A COMPILATION OF CASE HISTORIES,
Davis (Ken E.) Associates, Houston, TX.
For primary bibliographic entry see Field 5E.
W89-01577

OPERATION AND MAINTENANCE OF UNDERGROUND INJECTION WELLS,
Du Pont de Nemours (E.I.) and Co., Victoria, TX.
For primary bibliographic entry see Field 5E.
W89-01578

STUDY OF CURRENT UNDERGROUND INJECTION CONTROL REGULATIONS AND PRACTICES IN ILLINOIS,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 5E.
W89-01579

SITE SUITABILITY FOR WASTE INJECTION, VICKERY, OHIO,
Underground Resource Management, Inc., Austin, TX.
For primary bibliographic entry see Field 5E.
W89-01580

REMEDIATION OF GROUND-WATER CONTAMINATION RESULTING FROM THE FAILURE OF A CLASS I INJECTION WELL: A CASE HISTORY,
Louisiana Dept. of Natural Resources, Baton Rouge. Injection and Mining Div.
For primary bibliographic entry see Field 5G.
W89-01581

SUBSURFACE INJECTION IN ONTARIO, CANADA,

Underground Resource Management, Inc., Austin, TX.
For primary bibliographic entry see Field 2F.
W89-01582

SUBSURFACE INJECTION IN ONTARIO, CANADA,
Underground Resource Management, Inc., Austin, TX.
R. T. Kent, D. R. Brown, and M. E. Bentley.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1968. p 380-397, 6 fig, 9 ref.

Descriptors: *Injection wells, *Ontario, *Waste disposal, *Disposal wells, Deep wells, Waste management, Boreholes, Industrial wastes, Brine disposal, Environmental effects, Monitoring, Liquid wastes, Detroit River Formation.

Underground injection has been used in Ontario for decades to dispose of brackish waters and brines that are produced from oil and gas wells. The first injection well for liquid industrial waste was completed near Sarnia in 1958. In the next few years, a number of additional industrial injection wells were drilled near Sarnia. The majority of the wells were completed in the Detroit River Formation at depths generally less than 1,000 feet (304 m). This area was the site of intensive exploration for gas in the overlying Dundee Formation, and many cable-tool holes had been drilled to the top of the Detroit River Formation early in this century. In the late 1960's, several events occurred where industrial waste and/or brine flowed to the land surface through abandoned and inadequately plugged boreholes. As a result of these problems, industries in the Sarnia area voluntarily decreased their injection rate. Ultimately, regulations were passed which prohibited industrial waste injection into the Detroit River Formation. Since December 31, 1976, only brine has been injected into the Detroit River Formation. In order to evaluate the effects of brine injection, a regional assessment of injection of brines to the Detroit River formation was undertaken by the Ministry of the Environment. This project included an inventory of all injection wells in the Province, calculation of aquifer parameters from injection tests and drill stem tests, collection and review of chemical analysis of native brines, and a review of past operating practices. Data collected during the study suggested that continued injection into the Detroit River Formation could be safely accomplished by reducing well head operating pressures to prevent displacement of brines into freshwater aquifers. (See also W89-01564) (Author's abstract)
W89-01582

HYDROGEOLOGY OF SEDIMENTARY BASINS AS IT RELATES TO DEEP-WELL INJECTION OF CHEMICAL WASTES,
Texas Univ. at Austin. Bureau of Economic Geology.
C. W. Kreitler.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 398-416, 61 ref.

Descriptors: *Injection wells, *Sedimentary basins, *Waste disposal, *Disposal wells, *Geohydrology, Path of pollutants, Permeability, Saline water, Texas, Gulf of Mexico, Fluid flow, Deep wells, Liquid wastes, Groundwater movement.

The fate, transport, and confinement of chemical wastes injected into deep, saline formations are ultimately controlled by the regional hydrologic and geochemical environments of saline sections of sedimentary basins. The hydrogeology of sedimentary basins is as variable as there are different types of basins. Important parameters that control and describe a basin's hydrogeology are: (1) the geologic history of the basin, (2) flow mechanisms, (3) potential energy distributions, (4) permeability and permeability distribution of the rocks and sediments within the basin, (5) the occurrence of faults and fractures, and (6) the origin and age of saline waters. These parameters control residence times of waters, rates and directions of saline groundwater flow, the origin and chemical compositions of the saline waters, and, therefore, the ultimate fate of injected wastes. Examples of different types of sedimentary-basin hydrology and the importance of the controlling parameters are provided by comparing the hydrogeology of three basins in Texas - the Gulf of Mexico, the East Texas, and the Palo Duro sedimentary basins. The Gulf of Mexico is a relatively young, Tertiary-age basin which is presently compacting; fluid movement is considered to be up the stratigraphic dip or up fault zones and driven by shale compaction; fluid pressures are either hydrostatic or overpressured. The East Texas is an older, Cretaceous-age basin, parts of which may be stagnant. The Palo Duro is an older, Paleozoic-age basin that has been tectonically uplifted; fluid flow is gravity driven and fluid pressures are subhydrostatic. (See also W89-01564) (Author's abstract)
W89-01583

EVALUATION OF CONFINING LAYERS FOR CONTAINMENT OF INJECTED WASTEWATER,
Missouri Univ.-Rolla. Dept. of Geological Engineering.
D. L. Warner, S. N. Davis, and T. Syed.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 417-446, 3 fig, 3 tab, 39 ref. U.S. EPA Project 68-01-6389.

Descriptors: *Injection wells, *Site selection, *Waste disposal, *Disposal wells, *Geohydrology, Mathematical studies, Liquid wastes, Permeability, Porosity, Fluid flow, Geology, Chemical properties, Models, Performance evaluation.

The general technical requirements of a suitable wastewater injection well site include: (1) a saline-water bearing injection interval that is sufficiently thick, extensive, porous and permeable to accept wastewater at the necessary rate at safe injection pressures and which is not economically more valuable for its contained mineral resources or other uses; (2) overlying and underlying strata (confining beds) sufficiently thick, extensive and impermeable to confine waste to the injection interval; and (3) the absence of solution-collapse features, faults, extensive joints, or unplugged or improperly plugged abandoned wells that would permit escape of injected wastewater from the injection interval into adjacent aquifers. Since the advent of the use of injection wells for wastewater disposal, one of the more difficult technical issues has been the determination of the adequacy of confinement of injected liquids within the injection reservoir. This may be a particular problem when the confining interval is relatively thin, shallow, of questionable permeability, is affected by local structural or stratigraphic geologic features, or is penetrated by abandoned wells that may be improperly plugged. Assessment of the adequacy of a confining interval usually involves a general evaluation of the stratigraphy, structural geology, hydrogeology and hydrochemistry of the site. Specific geotechnical methods are also available for testing and modelling the behavior of confining strata, including the vertical extent of hydraulic fracture growth and the rate of flow of injected wastewater through them. More effort needs to be expended in determining the geological and engineering properties of confining layers during the drilling, logging and testing of injection and monitoring wells. Such additional information is required to allow improved evaluation of confining layer behavior and the fate and transport of injected contaminants. (See also W89-01564) (Author's abstract)
W89-01584

APPLICATION OF FLOW, MASS TRANSPORT, AND CHEMICAL REACTION MODELING TO SUBSURFACE LIQUID INJECTION,
Prickett (Thomas A.) and Associates, Urbana, IL.
For primary bibliographic entry see Field 5E.
W89-01585

ANALYSIS OF THE MIGRATION PATTERN OF INJECTED WASTES,
Oklahoma Univ., Norman. School of Petroleum and Geological Engineering.
E. C. Donaldson, and A. A. Rezaei.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 464-484, 5 fig, 8 ref.

Descriptors: *Geohydrology, *Injection wells, *Disposal wells, *Path of pollutants, *Waste disposal, *Mathematical models, Model studies, Computer models, Deep wells, Aquifer characteristics, Industrial wastes, Fluid flow.

In the planning stages of any subsurface waste injection system, the pattern of migration of the injected waste based on the known (or estimated) petrophysical properties of the brine aquifer and flow rate of the waste should be modeled. This is especially true when addition of a second, or third, well is planned for disposal of wastes into the same aquifer. This type of analysis will enable one to present a preliminary assessment of waste migration to a State Board or environmentally concerned citizens. A computer program was developed to track the advancing front of the injected waste as a function of time. The program can be used for any type of heterogeneous reservoir with variable thickness, permeability, porosity or flow boundaries such as faults. It also may be used to analyze disposal of wastes from multiple wells simultaneously or alternately. The program will compute the pattern whether regular or not, or the advancing waste-brine front. A complete discussion of the mathematical model, operating logic of the program, and listing of the program in FORTRAN is provided. Anyone with access to a computer can use this program to analyze the anticipated pattern of migration of injection wastes as a function of the petrophysical properties of the subsurface disposal formation and time. (See also W89-01564) (Author's abstract)
W89-01586

COMPARISON OF ANALYTICAL AND NUMERICAL METHODS FOR EVALUATING CROSS-FORMATIONAL FLOW AND SELECTING THE PREFERRED INJECTION AQUIFER, SWAN HILLS, ALBERTA, CANADA,
Alberta Research Council, Edmonton. Basin Analysis Group.
C. M. Sauveplane, S. Bachu, and B. Hitchon.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 485-508, 5 fig, 5 tab, 9 ref, append.

Descriptors: *Geohydrology, *Injection wells, *Disposal wells, *Waste disposal, *Aquifer characteristics, Numerical analysis, Aquitards, Mathematical models, Leakage, Leaky aquifers, Model studies, Alberta, Canada, Swan Hills, Alberta, Canada, Swan Hills.

A hydrogeological evaluation was carried out in a 15,760 sq km region centered on the special waste injection site of the Alberta Special Waste Management Corporation. The study was based on the examination and interpretation of stratigraphic and hydrogeologic information from 3276 wells, 635 drillstem tests, 3477 core analyses and 645 formation water analyses. Based on a detailed analysis of the natural flow system, seven major aquifer units and seven intervening aquitards (and minor aquicludes) were identified. The three-dimensional natural and perturbed flow regimes were simulated using a finite-element numerical model. Four of the major aquifer units were also studied using a non-leaky analytical model and a leaky two-aquifer analytical model. Estimates were made of the long-term hydraulic effects of injection, at a given rate of 225 cu m/day, into the four major aquifer units studied by means of analytical models, and predictions of hydraulic head build-up made and compared between the numerical and analytical methods. Analytical solutions show that the regime is quasi-steady-state after 100,000 years of constant-rate injection, but the hydraulic head build-ups calculated by the non-leaky model are greater than those obtained by both the leaky model and numerical simulation. Even when the leaky model is

applied at an optimal radial distance from the injection well, hydraulic head build-ups in adjacent aquifers are still overestimated compared to the numerical simulation; for aquifers generally less than 50 m thick, this overestimation results mainly from effects of the cone of influence and non-radial flow as well as from the limitations of the analytical model (only one leaky bed considered). Predictions of the hydraulic effects of injection based on analytical models should not neglect leakage through aquitards. The thicker the injection aquifer, the more closely will the predicted hydraulic head build-up approach that obtained. Even at rates as low as 225 cu m/day, reversal of the natural flow conditions can occur. (See also W89-01564) (Author's abstract)
W89-01587

INJECTION ZONE PRESSURE PROFILE,
Du Pont de Nemours (E.I.) and Co., Victoria, TX.
For primary bibliographic entry see Field 5E.
W89-01588

FLOW AND CONTAINMENT OF INJECTED WASTES,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
For primary bibliographic entry see Field 5E.
W89-01589

CHEMICAL FATE OF INJECTED WASTES,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
For primary bibliographic entry see Field 5B.
W89-01590

ROLE OF THE CRITICAL TEMPERATURE OF CARBON DIOXIDE ON THE BEHAVIOR OF WELLS INJECTING HYDROCHLORIC ACID INTO CARBONATE FORMATIONS,
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5E.
W89-01592

SUBSURFACE DISPOSAL OF LIQUID LOW-LEVEL RADIOACTIVE WASTES AT OAK RIDGE, TENNESSEE,
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 5E.
W89-01593

SUPERCRITICAL DEEP WELL WET OXIDATION OF LIQUID ORGANIC WASTES,
Vertox, Inc., Dallas, TX.
For primary bibliographic entry see Field 5D.
W89-01596

INTERPRETATION OF IN SITU GROUNDWATER QUALITY FROM WELL SAMPLES,
For primary bibliographic entry see Field 7C.
W89-01605

SORPTION KINETICS OF COMPETING ORGANIC SUBSTANCES ON NEW JERSEY COASTAL PLAIN AQUIFER SOLIDS,
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
For primary bibliographic entry see Field 5B.
W89-01643

HAZARDOUS WASTES IN GROUND WATER: A SOLUBLE DILEMMA.
Alberta Research Council, Edmonton.
Proceedings of the Second Canadian/American Conference on Hydrogeology. Banff, Alberta, Canada. June 25-29, 1985. Edited by Brian Hitchon and Mark R. Trudell. National Water Well Association, Dublin, OH. 1985. 255p.

Descriptors: *Groundwater pollution, *Contamination, *Hazardous materials, *Wastes, Geohydrology.

This volume contains the Proceedings of the Second Canadian/American Conference on Hydrogeology, which was jointly organized by the Alberta Research Council and the National Water Well Association. The subject of this year's conference was hazardous wastes and the wide variety of the papers presented attest to the importance of the subject and to the need for scientific input from many disciplines in order to solve what is generally regarded as a sensitive environmental and political problem. (See W89-01662 thru W89-01690) (Sand-PTT)
W89-01661

ROLE OF MASS TRANSPORT MODELING,
Alberta Univ., Edmonton. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W89-01662

INTERACTION OF CLAY AND INDUSTRIAL WASTE: A SUMMARY REVIEW,
McGill Univ., Montreal (Quebec). Geotechnical Research Centre.
For primary bibliographic entry see Field 5B.
W89-01663

NATURAL-GRADIENT EXPERIMENT ON ORGANIC SOLUTE TRANSPORT IN A SAND AQUIFER: SYNOPSIS OF RESULTS,
Stanford Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-01664

MIGRATION OF ORGANIC FLUIDS IMMISCIBLE WITH WATER IN THE UNSATURATED AND SATURATED ZONES,
Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W89-01665

GLOUCESTER PROJECT: A STUDY IN ORGANIC CONTAMINANT HYDROGEOLOGY,
Department of the Environment, Ottawa (Ontario). River Road Environmental Technology Center.
For primary bibliographic entry see Field 5B.
W89-01666

GROUND WATER CONTAMINATION BY ORGANIC CHEMICALS: UNCERTAINTIES IN ASSESSING IMPACT,
California Univ., Los Angeles. School of Public Health.
For primary bibliographic entry see Field 5B.
W89-01667

HOW TO ASSESS THE HAZARDOUS GROUND WATER CONTAMINATION POTENTIAL OF UNCONTROLLED WASTE SITES,
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
For primary bibliographic entry see Field 5B.
W89-01668

DISPOSAL SITE MONITORING DATA: OBSERVATIONS AND STRATEGY IMPLICATIONS,
Lockheed Electronics Co., Inc., Las Vegas, NV.
For primary bibliographic entry see Field 5B.
W89-01669

POTENTIAL RISKS TO A SOLE-SOURCE AQUIFER RECHARGE AREA FROM WASTE DISPOSAL ACTIVITIES: A CASE STUDY,
Geological Survey, Baton Rouge, LA.
For primary bibliographic entry see Field 5B.
W89-01670

CONCEPT OF EFFECTIVE POROSITY AND ITS MEASUREMENT IN SATURATED FINE-GRAINED POROUS MATERIALS,
Illinois State Water Survey Div., Champaign.
G. R. Peyton, J. P. Gibb, M. H. LeFaivre, and J. D. Ritchey.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 101-107, 1 fig, 22 ref.

Descriptors: *Porous media, *Soil, *Porosity, *Solute transport, *Path of pollutants, *Groundwater movement, Steric exclusion chromatography, Dispersion, Advection, Model studies.

The term 'effective porosity' has been used in the literature to identify many different concepts. Partially due to this lack of a clear definition, effective porosity is not recognized by some investigators. The concept of effective porosity presented in this paper arises from the idea that not all of the total porosity of a saturated porous medium may be available for solute transport. If some voids are of dimensions comparable to the molecular hydrodynamic radius, the available pore space may be different for molecules of different size. This makes effective porosity a function of solute as well as the soil matrix. One branch of liquid chromatography, called Steric Exclusion Chromatography, deals with the separation of solutes of varying molecular size, based on their difference in ability to diffuse into pores in the column packing material. The very existence of this branch of chromatography demonstrates the need to recognize the concept of effective porosity in hydrogeology. Concepts from chromatography theory are discussed and their relationship to classical dispersion/advection theory pointed out. The concept of reduced plate height provides a simple means by which to obtain an intuitive feel for the relative importance of dispersion and advection in predicting breakthrough. It is well known that breakthrough volumes in column experiments to determine porosity are dependent on the flow rate when flow is low enough that the diffusional portion of dispersion becomes important. Therefore, transport models must be used to decouple porosity information from the effects of dispersion column data obtained from low flow rates. (See also W89-01661) (Author's abstract)
W89-01672

SWAN HILLS FACILITY OF ALBERTA SPECIAL WASTE MANAGEMENT CORPORATION: EVALUATION FOR DEEP WASTE DISPOSAL,
Alberta Research Council, Edmonton.
For primary bibliographic entry see Field 5E.
W89-01673

ABSORPTION OF HALOGENATED ORGANIC COMPOUNDS BY POLYMER MATERIALS COMMONLY USED IN GROUND WATER MONITORS,
Gartner Lee Associates Ltd., Markham (Ontario).
For primary bibliographic entry see Field 5A.
W89-01674

SOIL VAPOR MONITORING AS A COST-EFFECTIVE METHOD OF ASSESSING GROUND WATER DEGRADATION FROM VOLATILE CHLORINATED HYDROCARBONS IN AN ALLUVIAL ENVIRONMENT,
Kleinfelder (J.H.) and Associates, Walnut Creek, CA.
For primary bibliographic entry see Field 5A.
W89-01675

NATURAL-GRADIENT TRACER STUDY OF DISSOLVED BENZENE, TOLUENE AND XYLENES IN GROUND WATER,
Waterloo Univ. (Ontario).
For primary bibliographic entry see Field 5B.
W89-01676

GEOPHYSICAL SURVEY TO INVESTIGATE CONTAMINANT MIGRATION FROM A WASTE SITE,
Woodward-Clyde Consultants, Baton Rouge, LA.
For primary bibliographic entry see Field 5B.
W89-01677

IMPEDANCE COMPUTED TOMOGRAPHY ALGORITHM AND SYSTEM FOR GROUND WATER AND HAZARDOUS WASTE IMAGING,
Manitoba Univ., Winnipeg. Dept. of Electrical Engineering.
A. Wexler, and C. J. Mandel.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 156-161, 5 fig, 7 ref.

Descriptors: *Groundwater pollution, *Contamination, *Geophysics, *Path of pollutants, *Tomography, *Impedance computed tomography, Wastes, Hazardous materials, Algorithms.

An impedance computed tomography algorithm and system, for impedance imaging with top-surface measurements, are described. The algorithm, which determines the current flow paths iteratively, employs sparse-matrix techniques and so a large number of variables is easily accommodated. The easurement system used a grid of electrodes over the ground surface and introduces controlled currents into a subset of electrodes in a prescribed. sequence. Voltage measurements (using high impedance equipment) are taken at passive electrodes only. Therefore, uncertain contact and spreading resistance are not of primary concern to the scheme. Fine image resolution is attainable with accurate measurements. It is not required that buried objects be layered and broad in extent in order to be imaged from the top surface. Three tests are reported in which an 80mm mortar shell, submerged in water and buried in sand, is imaged by top-surface measurements only. (See also W89-01661) (Author's abstract)
W89-01678

TOMOGRAPHIC IMAGING OF GROUND WATER POLLUTION PLUMES,
Faraci (E.J.) and Associates, Winnipeg (Manitoba).
A. Tamburi, R. Allard, and U. Roeper.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 162-167, 8 fig, 10 ref.

Descriptors: *Groundwater pollution, *Contamination, *Geophysical surveys, *Tomography, *Path of pollutants, *Impedance computed tomography, Wastes, Hazardous materials, Algorithms, Electroscan, Plumes.

An impedance tomographic technique developed by Wexler and Mandel was assessed for its potential application as an imaging tool for ground water pollution plumes. The technique, referred to as the Electroscan method, is a new geophysical tool rather than a rearrangement of traditional resistivity techniques. It is a three-dimensional tool, which simultaneously solves systems of equations for the distribution of conductivity throughout the region beneath an electrode grid. Less information is lost with increasing depth than traditional methods, and for a given electrode, spacing definition of detail is superior to traditional methods. The Electroscan was used in a laboratory flume to image saline plumes injected into a one-dimensional background flow field. The techniques successfully imaged dispersion both horizontally and vertically and advection of an injected pollutant slug. The Electroscan was also used at a field site near Portage la Prarie. A portion of the plume coming off the landfill was chosen as the target. Results from the field site were less spectacular due to a lower signal to noise ratio and the flow of electric current outside the electrode array. Shadows of high conductivity features may be propagated beneath, or parallel to the feature. Expansion to a 16 x 16 array, electronic switching, and computational improvements to the algorithm are anticipated future developments. (See also W89-01661) (Author's abstract)
W89-01679

COMPARISON OF LANDFILL DESIGN ALTERNATIVES BASED ON GROUND WATER FLOW MODELING,
Gartner Lee Associates Ltd., Markham (Ontario).
For primary bibliographic entry see Field 5E.
W89-01680

GROUND WATER CONTAMINATION ASSOCIATED WITH WASTE DISPOSAL INTO A WATER-FILLED OPEN-PIT COAL MINE,
Alberta Environment, Edmonton.
For primary bibliographic entry see Field 5B.
W89-01683

CYANIDE CONTAMINATION NEAR ELK CITY, IDAHO: THE REGULATORY IMPLICATIONS,
Idaho State Dept. of Health and Welfare, Boise.
For primary bibliographic entry see Field 5B.
W89-01685

INVESTIGATION OF GROUND WATER QUALITY AT A DECOMMISSIONED SOUR GAS PLANT IN ALBERTA,
Monenco Consultants Ltd., Calgary (Alberta).
For primary bibliographic entry see Field 5B.
W89-01686

EFFECTS OF THE 1982 AMOCO-DOME BRAZEAU RIVER GAS WELL BLOWOUT ON THE SUBSURFACE ENVIRONMENT,
Campbell Geoscience Ltd., Calgary (Alberta).
For primary bibliographic entry see Field 5B.
W89-01687

GROUNDWATER AND WELLS,
F. G. Driscoll.
Johnson Division, St. Paul, Minnesota. 1986. 1089p. 2nd ed.

Descriptors: *Groundwater, *Wells, Aquifers, Weather, Hydrologic cycle, *Groundwater movement, *Well hydraulics, *Drilling, Water chemistry, Drilling fluids, Design standards, Pumps, Groundwater quality, Maintenance, Monitoring, Legal aspects, Water treatment, Water use.

A comprehensive study of groundwater and groundwater technology includes: formation of Aquifer Systems; Weather Patterns and the Hydrologic Cycle; Occurrence and Movement of Groundwater; Groundwater Chemistry; A Summary of Groundwater Resources of North America; Groundwater Exploration; Well Hydraulics; Well Drilling methods; Drilling Fluids; Well Screens and Methods of Sediment-Size Analysis' Water Well Design; Installation and Removal of Well Screens; Development of Water Wells; Collection and Analysis of Pumping Test Data; Water Well Pumps; Water-Quality Protection for Wells and Nearby Groundwater Resources; Well and Pump Maintenance and Rehabilitation; Groundwater Law, Water Well Specifications, and Well Contract Problems; Groundwater Monitoring Technology; Alternative Uses for Wells and Well Screens; Water Treatment; and Wise Use of Groundwater. The text is augmented with 440 illustrations, 141 photographs, and 149 tables. Technical data are presented in 90 appendices; examples include the dimensions, weights, and strengths for low-carbon steel, stainless steel, and thermoplastic casing, rotation speeds for all sizes and types of bits in various formations, field welding procedures, pump troubleshooting chart, and recommended treatments for water quality problems. A glossary has been added listing nearly 200 important terms applying to water well technology. (Lantz-PTT)
W89-01766

APPLIED HYDROGEOLOGY,
Wisconsin Univ.-Oshkosh.
For primary bibliographic entry see Field 2A.
W89-01801

MODELING GROUNDWATER FLOW AND POLLUTION: WITH COMPUTER PROGRAMS FOR SAMPLE CASES,
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
J. Bear, and A. Verruijt.
D. Reidel Publishing Co., Boston, Massachusetts. 1987. 414p.

Descriptors: *Groundwater movement, *Pollutant transport, *Model studies, *Path of pollutants, Flow profiles, Aquifers, Mathematical models, Mathematical studies, Computer programs, Advection, Dispersion, Saline water studies.

The general principles involved in groundwater flow and pollutant transport by groundwater are discussed with special attention given to both the understanding of the physical mechanisms that govern the movement and the accumulation of groundwater and pollutants in aquifers and to the construction of conceptual, mathematical and numerical models. A large part of the book is concerned with actual numerical models, mainly based on the finite difference and finite element methods. A large number of complete computer programs, in BASIC, are included. The programs can be run on personal computers and are both educational and 'semi-professional'. Programs are presented for both steady and unsteady two-dimensional flow in nonhomogeneous aquifers, for flow through dams, for the transport of pollutants by advection and by dispersion, and for saltwater intrusion problems. (Lantz-PTT)
W89-01810

MODERN TRENDS IN TRACER HYDROLOGY. VOLUME I.
CRC Press, Inc., Boca Raton, FL. 1987. 145p. Edited by Emilian Gaspar.

Descriptors: *Groundwater movement, *Geohydrology, *Tracers, Environmental tracers, Statistical methods, Hydrology, Radioactive tracers, Monte Carlo Method, Porous media, Filtration, Flow profiles, Flow velocity, Permeability, Aquifers, Computer models, Model studies, Flow pattern, Simulation analysis.

The ever-pressing need for potable and industrial waters as well as the intensive exploitation of geothermal waters in conditions in which stringent ecological problems have cropped up owing to a continuous rise in water pollution, call for ever more accurate techniques for assessment and optimization of the exploitation and management of these resources. Owing to the scarcity of aquifer resources, various solutions ranging from the great-depth drillings in the Sahara to the capitalization of the aquiferous potential of Antarctica, have been adopted. After 1960, constant attention has been paid to the supplementation of the classical methods with tracer techniques (environmental isotopes and artificial tracers) in order to use the natural resources of the earth. The rising interest in tracer hydrology is particularly significant since the problems related to the development of water resources are among the most vital questions that face the world today. For this reason, and not only in this field, cooperation is now even more essential than before. Chapter 1 deals with the most important natural (environmental isotopes, the water chemistry, microfauna) and artificial tracers (fluorescent dyes, salts, radioactive and activable isotopes, biological or other tracers) and highlights their characteristics and limitations, as well as the prospects of their utilization. The behavior of artificial tracers is approached in Chapter 2, which also refers to the factors that contribute to the variation in tracer concentration in time and space as a result of the physical, chemical, and biological interactions with the air, water, rocks, and the biological medium in which it moves. Modern tracer methodology, data processing, the selection of flow patterns, the use of transfer functions, the principles of the Monte Carlo method, and computer simulation are the themes of Chapters 3 and 4. (See W89-01981 thru W89-01985; W89-01986) (Lantz-PTT)
W89-01981

HYDROLOGICAL TRACERS,
Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
For primary bibliographic entry see Field 7B.
W89-01982

BEHAVIOR OF ARTIFICIAL TRACERS,

Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
For primary bibliographic entry see Field 7B.
W89-01983

MODERN TRENDS IN TRACER HYDROLOGY. VOLUME II.
CRC Press, Inc., Boca Raton, FL. 1987. 137p.
Edited by Emilian Gaspar.

Descriptors: *Groundwater movement, *Geohydrology, *Tracers, Environmental tracers, Hydrology, Radioactive tracers, Monte Carlo Method, Porous media, Filtration, Flow profiles, Flow velocity, Permeability, Aquifers, Computer models, Model studies, Flow pattern, Simulation analysis, Geothermal resources, Karst hydrology.

The ever-pressing need for potable and industrial waters as well as the intensive exploitation of geothermal waters in conditions in which stringent ecological problems have cropped up owing to a continuous rise in water pollution, call for ever more accurate techniques for assessment and optimization of the exploitation and management of these resources. Owing to the scarcity of aquifer resources, various solutions ranging from the great-depth drillings in the Sahara to the capitalization of the aquifer potential of Antarctica, have been adopted. After 1960, constant attention has been paid to the supplementation of the classical methods with tracer techniques (environmental isotopes and artificial tracers) in order to use the natural resources of the earth. The rising interest in tracer hydrology is particularly significant since the problems related to the development of water resources are among the most vital questions that face the world today. For this reason, and not only in this field, cooperation is now even more essential than before. Chapter 5 is a review of the radioactive tracer methods involved in determinations of the characteristics of water flow through porous media (filtration velocity, real velocity, flow direction, vertical streams) and of the parameters of water-bearing layers (permeability, porosity, dispersivity) with the help of one or several wells. A special chapter (6) is devoted to tracer study of hydrokarstic structures owing to the topical character of this field; carbonaceous rocks cover roughly 10% of the continental area which feature karstification processes. Specific methodology, goals, and prospects of tracings in karsts case studies are presented, analyzed, and discussed. Chapter 7 is related to the investigation of geothermal systems using environmental isotopes, noble gases, dating of thermal waters, and chemical and isotopic geothermometers. (See W89-01987 thru W89-01989; W89-01981) (Lantz-PTT)
W89-01986

CHARACTERISTICS OF AQUIFERS IN POROUS MEDIA,
Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
E. Gaspar.
IN: Modern Trends in Tracer Hydrology. Volume II. CRC Press, Inc., Boca Raton. 1987. p 1-30, 11 fig, 62 ref.

Descriptors: *Geohydrology, *Aquifer characteristics, *Aquifers, *Groundwater movement, *Porous media, *Hydrologic properties, *Tracers, Radioactive tracers, Flow profiles, Hydrologic studies, Flow patterns.

A rational exploitation of aquifer calls for accurate knowledge of both the characteristics of water-bearing strata and the dynamics of underground waters. Artificial tracers, and, among them, radioactive tracers in particular, have been broadly applied to saturated porous media and sometimes also to aquifers of consolidated media. They allow for quite accurate assessments - and at a low price, for that matter - of both flow characteristics and certain constants of the investigated medium. The tracer methods that use one or more wells are generally additional methods of study which, in combination with other techniques, yield remarkable results. Single- and multiwell techniques supply information concerning morphology and hydrological behavior in the different subsurface layers which are crossed by a well; these pieces of information cannot be obtained through other methods. Single-well data reflect microscopic flow patterns. That is why single-well techniques are employed when highly detailed hydrogeological information is needed. Multiwell techniques are unique methods of determining either the hydrological features or the vulnerability of aquifers to chemical, radioactive, or bacteriological pollution; furthermore, they may also be employed as methods to complement conventional investigations or investigations based on environmental tracers. Moreover, both the basic theory behind these techniques and the experimental methods have been perfected. Consequently, an important evolution in the near future cannot be expected; however, their applications will expand. (See also W89-01986) (Lantz-PTT)
W89-01987

FLOWTHROUGH HYDROKARSTIC STRUCTURES,
Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
E. Gaspar.
IN: Modern Trends in Tracer Hydrology. Volume II. CRC Press, Inc., Boca Raton. 1987. p 31-93, 40 fig, 1 tab, 101 ref.

Descriptors: *Karst, *Karst hydrology, *Groundwater movement, *Hydrologic studies, *Tracers, Sinks, Geohydrology, Model studies, Precipitation, Discharge, Evapotranspiration, Radioisotopes, Radioactive tracers, Mathematical studies.

Flow in karstic structures may be modeled if the input and output functions are known. The input and output functions may be the chronological series of precipitations, on one had, and the outflowing discharges, on the other. A number of difficulties is encountered: precipitation measurements are known to be less accurate (as their special variability is substantial), evapotranspiration is difficult to assess, and the relations employed to compute it are not altogether satisfactory. As they are used in the study of karst behavior, artificial tracers may supply special items of information if successive labelings are performed in periods of low flow, in periods of flood, or under conditions of mean discharges. However, prior to applying transfer functions to the study of karst behavior, the system under investigation should be defined. There are two methods whereby research aimed at defining a karstic system may be approached: (1) Knowledge of all losses and outflows from karst to establish whether or not it belongs to a system; and (2) Research into the possibilities of the existence of excess outlets (which are therefore operational only in cases of high discharges) or of uncontrolled inputs, starting from a surveillance of the main emergence of the system. Recent research under way in various laboratories will encourage the use of tracer methods in karsts, aimed at the following major targets: (1) The expansion of the range of artificial tracers which should not be contained in the investigated medium; (2) The use of advanced techniques to measure small amounts of environmental isotopes and determine the water imprint given by the natural elements that are dissolved in concentrations below 10 to the -11th gm/cu cm; (3) The improvement of knowledge in the range of values for basic aquifer parameters of the conduit, diffuse, and fissure systems, a very promising technique being the use of the variability of natural radon activity in groundwaters as a measure of the importance of fissure flows and water mobility; and (4) The development of mathematical patterns to model the flow of water in karsts for vast areas, under different hydrological conditions, to achieve an interpretation of experimental data as close to reality as possible. (See also W89-01986) (Lantz-PTT)
W89-01988

TRACER INVESTIGATIONS IN GEOTHERMAL SYSTEMS,
Institutul de Meteorologie si Hidrologie, Bucharest (Romania). Environmental Isotope Lab.
A. Tenu.
IN: Modern Trends in Tracer Hydrology. Volume II. CRC Press, Inc., Boca Raton. 1987. p 95-130, 9 fig, 2 tab, 133 ref.

Descriptors: *Geothermal studies, *Tracers, *Groundwater movement, *Thermal waters, *Geohydrology, Groundwater recharge, Hydrologic studies, Noble gases, Isotopes, Aquifers, Water budget, Thermal conductivity.

Unlike other energy resources connected with the geologic field - coal, oil, and uranium ores - geothermal water exploitation displays a peculiarity in that hot waters are theoretically renewable through recharge from recent waters. It is therefore necessary to thoroughly study the aquifer not only from a geometrical, quantitative, and qualitative standpoint but also from a hydrodynamic one. In order to study the geometrical requirements, combined classical methods (geological, geophysical, hydrogeological, hydrogeochemical, etc.) were resorted to which ultimately led to the identification of the water-bearing formations and their geometrical parameters, to the hydraulic and hydrochemical point characteristics, and even to the computation of the stored water volume. Nevertheless, the major problem to be solved with most geothermal aquifers is the accurate assessment of their exploitation, given stable quantitative and qualitative characteristics over time, required first and foremost for economic reasons. An essential contribution to the elucidation of these problems may be made by geochemical methods, particularly by the environmental isotopes, as they display wide possibilities for tracing actual water molecules along their track into the ground and for establishing their relative age. Moreover, other aspects connected with the study of geothermal fluids may be explained: the modifications occurring in the process of cooling by thermal conductivity during the rise of water up to the surface, the mixture with cold water, or the vapor losses. The chemical and isotopic tracers are very helpful at the prospecting and exploration stages in assessing the fluid temperature in the geothermal reservoir, taking into account the natural and artificial emergences in the area. Similarly, the variations within the contents of the noble gases used as tracers may largely contribute to useful elucidations at all research stages on geothermal waters, supporting or refuting certain hypotheses suggested by other geochemical methods. (See also W89-01986) (Lantz-PTT)
W89-01989

RURAL GROUNDWATER CONTAMINATION.
Lewis Publishers, Inc., Chelsea, Michigan, 1987. 416p. Edited by Frank M. D'Itri and Lois G. Wolfson.

Descriptors: *Nonpoint pollution sources, *Groundwater pollution, *Rural areas, *Water pollution sources, Landfills, Municipal wastewater, Hazardous wastes, Farm wastes, Drinking water, Monitoring, Model studies, Pesticides.

Public concern has risen as increasing population and industrial growth have placed heavier demands on the existing water supply system, especially groundwater. In excess of 95% of this nation's rural inhabitants and > 50% of its urban residents depend on groundwater for drinking water. Pollution of groundwater from industrial, domestic and agricultural chemicals presents a serious threat. For example, there are an estimated 181,000 industrial surface lagoons or impoundments in addition to more than 16,000 industrial landfill sites containing hazardous wastes, 18,500 active municipal landfills, and 20 million septic systems. Each year in the United States, farmers apply approximately 11.5 million tons of commercial nitrogen fertilizers and 1.1 billion tons of animal manure. In addition, approximately 700 million pounds of pesticides are used in the United States each year, and between 3.5 and 21 million pounds (0.5% to 3%) are estimated to gravitate to the ground or surface water resources. The book is organized into six major sections: (1) overview; (2) sources and impacts; (3) assessment and modeling; (4) drinking water standards, health implications and risk considerations; (5) regulation and remedial action; and (6) strategies and assistance. (See W89-02197 thru W89-02222) (Lantz-PTT)
W89-02196

NITRATES IN IOWA GROUNDWATER,
Iowa Dept. of Natural Resources, Iowa City.
For primary bibliographic entry see Field 5B.
W89-02199

GROUNDWATER PROBLEM IN MICHIGAN: AN OVERVIEW,
Michigan State Univ., East Lansing. Inst. of Water Research.
K. M. Kittleson.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 69-84, 8 fig, 1 tab, 4 ref.

Descriptors: *Model studies, *Groundwater pollution, *Michigan, *Groundwater quality, Public participation, Path of pollutants, Information exchange, Databases, Computer models, Water quality.

The most serious and fundamental groundwater problem Michigan faces is communication. Specifically, the problem is how to deal with the complex maze of data and information that is available on groundwater quality issues. These problems range from mechanisms of chemical and biological transport (which are often simulated with computer programs) to the difficult regulation and policy decisions about groundwater. Three major topics are addressed: (1) a brief summary of the Michigan groundwater problem; (2) a suggestion of a general strategy for responding to this problem; and (3) an example of the proposed strategy. The type of system which has been developed to address this problem at Michigan State University is the Spatial Information Management System (SIMS). SIMS consists of the following components: (1) geographic information system; (2) a tabular data base containing water quality data; and (3) a series of computer models which make generalizations and forecasts based on the geographic information system and tabular data base. (See also W89-02196) (Lantz-PTT)
W89-02200

IMPACTS OF CHEMIGATION ON GROUNDWATER CONTAMINATION,
Science and Education Administration, Lincoln, NE
For primary bibliographic entry see Field 5B.
W89-02202

ASSESSING ANIMAL WASTE SYSTEMS IMPACTS ON GROUNDWATER: OCCURRENCES AND POTENTIAL PROBLEMS,
Soil Conservation Service, Washington, DC.
For primary bibliographic entry see Field 5B.
W89-02203

GROUNDWATER CONTAMINATION FROM LANDFILLS, UNDERGROUND STORAGE TANKS, AND SEPTIC SYSTEMS,
Michigan Dept. of Natural Resources, Lansing. Groundwater Quality Div.
For primary bibliographic entry see Field 5B.
W89-02205

ABATEMENT OF NITRATE POLLUTION IN GROUNDWATER AND SURFACE RUNOFF FROM CROPLAND USING LEGUME COVER CROPS WITH NO-TILL CORN,
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
For primary bibliographic entry see Field 5G.
W89-02206

GROUNDWATER MONITORING: AN OVERVIEW FROM FIELD DRILLING TO LABORATORY ANALYSIS,
Keck Consulting Services, Williamston, MI.
For primary bibliographic entry see Field 5A.
W89-02209

HEALTH IMPLICATIONS OF GROUNDWATER CONTAMINANTS,
Michigan State Univ., East Lansing. Center for Environmental Toxicology.
For primary bibliographic entry see Field 5C.
W89-02211

WELL CONSTRUCTION: DRILLING, LOCATION AND SAFETY,
Michigan Dept. of Public Health, Lansing.
For primary bibliographic entry see Field 8A.
W89-02215

INDUSTRY/AGENCY PERSPECTIVES ON STRATEGIES FOR PROTECTING GROUNDWATER,
National Agricultural Chemicals Association, Washington, DC.
For primary bibliographic entry see Field 6E.
W89-02220

ESTIMATION OF NATURAL GROUNDWATER RECHARGE.
Mathematical and Physical Sciences Vol. 222, D. Reidel Publishing Co., Boston, Massachusetts. 1988. 510p. Edited by I. Simmers.

Descriptors: *Groundwater recharge, *Infiltration, *Groundwater movement, *Geohydrology, Model studies, Arid lands, Semiarid lands, Case studies, Mathematical studies, Mathematical models, Chemical analysis, Physical analysis, Aquifers, Recharge, Groundwater supply.

Although recharge mechanisms are reasonably well known, deficiencies are evident in quantifying the various elements - in this respect the use of tracer techniques and remote sensing offer interesting potential. Differences in sources and processes of recharge in humid climates compared with arid/semi-arid areas mean that applicability of available estimation techniques will be different. Under arid conditions recharge is intermittent and concentrated in small areas. In many instances, especially in developing countries, there are inadequate data to obtain reasonable recharge model calibration. However, in most cases, if a flexible approach to project design or management strategy is adopted, the necessary data can be collected within the operation of normal groundwater production. A workshop was held to critically address such specific topics as recharge determination methodology, estimation with inadequate data and regionalization of point observations. This volume represents the formal proceedings of this meeting, and contains delivered keynote addresses and a selection of the offered papers divided into the following subject headings: groundwater recharge concepts; groundwater recharge estimation: physical/chemical methods; groundwater recharge estimation: numerical modelling techniques; applications and case studies; and zone humid recharge: a comparative analysis. (See W89-02224 thru W89-02255) (Lantz-PTT)
W89-02223

GROUNDWATER RECHARGE CONCEPTS,
Stavebni geologie n.p., Gorkeho nam. 7, 113 09 Prague 1, Czechoslovakia.
J. Balek.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 3-9, 16 ref.

Descriptors: *Groundwater recharge, *Infiltration, *Recharge, Aquifers, Saturation zone, Aeration zone, Flow profiles, Groundwater movement, Vertical flow, Horizontal flow, Arid lands, Semiarid lands.

The present state of knowledge in the field of groundwater recharge does not allow any particular preferred concept for future research. However, results which have been achieved elsewhere are at least worthwhile for selecting particularly important topics. One of them seems to be analysis of the disproportion between the concept of regionally smoothed properties of the soil/aquifer system on one hand and possible occurrence of preferred pathways on the other. These conclusions can lead to a qualitatively new point of view on the vertical flow in unsaturated and saturated zones. Also the combined effect of vertical and horizontal recharge time of residence and its variability needs to be analyzed in relation to the validity of water balance equations. A joint impact of all parameters influencing the recharge processes should be analyzed by statistical and deterministic methods. In particular the role of changing vegetational pattern in the formation of groundwater recharge should be examined. As far as arid and semiarid regions are concerned, more experiments and measurements of groundwater recharge have to be performed under ecological conditions of aridity. Such an approach may result in more definite conclusions on the regional validity of various concepts developed under temperate conditions. Groundwater recharge processes should be analyzed in the regions with sparse localized water supply with the aim to develop effective methods of recharge regulation. (See also W89-02223) (Lantz-PTT)
W89-02224

UNEXPECTED FACTOR AFFECTING RECHARGE FROM EPHEMERAL RIVER FLOWS IN SWA/ NAMIBIA,
Department of Water Affairs, Windhoek (Namibia).
S. Crerar, R. G. Fry, P. M. Slater, G. van Langenhove, and D. Wheeler.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 11-28, 12 fig, 4 tab, 2 ref.

Descriptors: *Groundwater recharge, *Ephemeral streams, *River flow, *Namibia, *Surface-groundwater relations, *Recharge, *Alluvial aquifers, Floods, Channels, Silt, Aquifers.

The processes controlling recharge to alluvial groundwater have presented complex and even intractable hurdles to accurate estimates of this parameter. Casual observations in ephemeral rivers in SWA/Namibia have indicated that variable recharge quantities result from similar flood events. For this reason the Department of Water Affairs initiated a research project to identify and investigate relevant parameters. To achieve these objectives three carefully chosen natural channel sections were identified for instrumentation, a simulated channel was constructed under laboratory conditions and the basis of a mathematical model laid down. This paper comments on the field and laboratory instrumentation applied and the results derived from the first fully instrumented natural river channel for which two seasons of flood flow and resultant recharge data are available. These results are compared with laboratory trials for a range of flow regimes. While this work is at an early stage, it has already become clear that silt carried by flood waters can effectively seal the alluvial surface even during the flood event at unexpectedly high flow velocities. Thus the other processes controlling recharge in the unsaturated zone may become relatively unimportant for much of the duration of any given flood event. (See also W89-02223) (Author's abstract)
W89-02225

CONTINUITY OF AQUIFER SYSTEMS ON THE CRYSTALLINE BASEMENT OF BURKINA FASO,
Iwaco B.V., Rotterdam (Netherlands).
J. J. van der Sommen, and W. Giernaert.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 29-45, 10 fig, 2 tab, 14 ref.

Descriptors: *Aquifer systems, *Burkina Faso, *Groundwater budget, *Geologic formations, *Geohydrology, *Groundwater movement, Flow profiles, Fracture permeability, Permeability, Water supply.

Two components of one aquifer system can be distinguished in Burkina Faso: The alteration zone and the fractured bedrock aquifer. Where a saturated weathered mantle is present over large areas

the aquifer may be considered as continuous. It was found that even in regions with a thin or absent saturated weathered mantle, continuity in the aquifer system must be present. Fluctuations of the groundwater table and piezometric contour maps have shown that a regional recharge-discharge system is present. A rough groundwater balance in the central part of the country and chloride concentrations in the groundwater provide evidence that the main discharge system is lateral groundwater flow. This flow is concentrated in the fractured bedrock as permeabilities of the weathered mantle are very low. The volume of lateral flow is of the same order of magnitude as the actual recharge. In the north, with lower actual recharge and only a thin or absent saturated weathered mantle, continuity of the aquifer system is less evident but regional groundwater flow does occur. In the south, with a thick weathered mantle and higher groundwater tables, weathering processes are more intense resulting in a higher degree of continuity. The study for the future water supply of Ougadougou has shown that for high yield urban water supply wells, both components of the aquifer system should be well developed, i.e. a thick saturated weathered mantle and fractured bedrock with good lateral continuity. Exploration for urban wells should therefore be focussed on first delineating areas with a thick saturated mantle and subsequently locating within this area the broken zones. (See also W89-02223) (Lantz-PTT)
W89-02226

REVIEW OF SOME OF THE PHYSICAL, CHEMICAL AND ISOTOPIC TECHNIQUES AVAILABLE FOR ESTIMATING GROUNDWATER RECHARGE,
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Soils.
G. B. Allison.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 49-72, 5 fig, 76 ref.

Descriptors: *Groundwater recharge, *Recharge, *Tacers, *Hydrologic data collections, Radioisotopes, *Literature review, Aquifers, Tritium, Recharge, Isotopic tracers, Estimation.

In this review, only some of the techniques available for estimating groundwater recharge have been presented. The discussion has concentrated on recharge to unconfined aquifers in areas of reasonably low rainfall (<700 mm/a). It is likely that, the greater the aridity, the smaller and more variable the recharge flux will become. This suggests that chemical and isotopic methods are likely to be more successful than the physical methods which rely on a direct measurement of a water flux. An additional advantage of tracers is that their diffusivity is much less variable with change in water content or soil type than the diffusivity of soil water. In estimation of recharge, a tracer like tritium relies on estimation of the amount of the tracer beneath the soil surface, thus the precision of the estimate of recharge will increase with recharge rate. In contrast, for a tracer like chloride, the concentration of which is inversely proportional to recharge rate, the precision of the estimate will increase with decrease in recharge rate. The estimation of recharge rate from investigations of profiles of tracer concentration (e.g. chloride) under some conditions, relies critically on a knowledge of the tracer diffusivity and hence on tortuosity. Estimation of this parameter remains a critical problem. Probably the most difficult and important problem to be overcome in estimation of recharge is the prediction and assessment of its variability. Over some quite large areas it appears to show little lateral variability, while in other, apparently similar areas it can range over at least an order of magnitude. (See also W89-02223) (Lantz-PTT)
W89-02227

PROPOSED STUDY OF RECHARGE PROCESSES IN FRACTURE AQUIFERS OF SEMI-ARID BOTSWANA,
Botswana Univ., Gaborone. Faculty of Science.
A. Gieske, and E. Selaolo.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 117-124, 2 fig, 18 ref.

Descriptors: *Groundwater recharge, *Aquifer, *Semiarid lands, *Botswana, *Recharge, *Infiltration, *Fracture permeability, Hydrologic budget, Evapotranspiration, Aeration zone, Groundwater, Rainfall, Recharge, Permeability.

Determination of groundwater recharge in semi-arid regions by the classical water balance approach is of limited practical value, because in general the evapotranspiration and the groundwater discharge component are not directly measurable. Moreover, the storage of moisture in the unsaturated zone and the rates of infiltration along the various possible routes to the aquifer form important and uncertain factors. Linked in with plans to extend and upgrade the existing groundwater monitoring network of important aquifers in eastern Botswana, a thorough and long-term study is proposed, not only of moisture transport but also of dynamic aspects of groundwater replenishment. Most difficult to analyze is the infiltration through thin soils of varying permeability into fissures and cracks of underlying rocks. It seems that some of these processes are also non-linear functions of accumulated rainfall for the simple reason that soil permeability increases with moisture content and when saturation has been reached, the rate of infiltration is determined by the height of the ponded water on the surface. In the analysis of the complete system of the aquifer and its catchment, a careful study must be made of this dynamic response of each of the elements in the system to possible successions of rainfall events. This can only be done when the whole range of soil physical, isotopic and solute transport methods is applied to a few test areas over an extended period of time. (See also W89-02223) (Lantz-PTT)
W89-02230

ESTIMATION OF NATURAL GROUNDWATER RECHARGE UNDER SAUDI ARABIAN ARID CLIMATIC CONDITIONS,
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Hydrogeology.
M. J. Abdulrazzak, A. U. Sorman, and O. A. Rizaiza.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 125-138, 7 fig, 3 tab, 3 ref.

Descriptors: *Groundwater recharge, *Saudi Arabia, *Arid lands, *Recharge, *Infiltration, Model studies, Aquifers, Wadis, Data acquisition, Rainfall, Runoff, Evapotranspiration, Soil temperature, Soil water, Regression analysis, Flood hydrographs.

Investigated is the infiltration-recharge phenomena in a representative alluvial wadi system in order to determine the factors influencing it, and formulate a groundwater recharge model. To achieve this goal a three kilometer experimental reach in one of the representative basins of the south-western part of Saudi Arabia was selected and instrumented with a data acquisition system to continuously monitor hydrological variables on rainfall, runoff, groundwater fluctuations, evapotranspiration, and soil temperature and moisture variation. Analysis of data revealed different recharge responses at each well due to soil heterogeneity and moisture variation. The developed regression models show that the maximum flood hydrograph depth is the most important influencing factor affecting recharge. Also, factors such as rainfall depth and depth to water table affected the recharge rate. (See also W89-02223) (Author's abstract)
W89-02231

SOLUTE PROFILE TECHNIQUES FOR RECHARGE ESTIMATION IN SEMI-ARID AND ARID TERRAIN,
British Geological Survey, Wallingford (England). Hydrogeology Research Group.
W. M. Edmunds, W. G. Darling, and D. G. Kinniburgh.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 139-157, 6 fig, 4 tab, 14 ref.

Descriptors: *Groundwater recharge, *Semiarid lands, *Arid lands, *Tracers, *Solute transport, *Recharge, *Water table profiles, Profiles, Solutes, Estimating, Tritium, Data interpretation, Aeration zone, Chloride, Cyprus, Sudan, Recharge.

Conventional methods for recharge estimation have limitations when applied to arid and semiarid regions; the use of tritium profiles is also not always applicable. Unsaturated zone solute profiles, using a reference solute such as chloride, offer an alternative technique. Sampling may be undertaken by percussion drilling, augering or from dug wells; the methods developed are described and examples discussed. Recharge estimates using chloride profiles from Cyprus (420 mm mean annual rainfall) are in good agreement with results estimated from tritium profiles and indicate a mean annual recharge of around 50 mm/yr. In Central Sudan (180 mm mean annual rainfall), good agreement was found between adjacent unsaturated zone chloride profiles and these indicated a net annual direct recharge via interfluve areas of around 1 mm/yr. It is concluded that solute profiles offer a cheap and effective tool for estimating direct recharge history, providing input data for chloride are available. In more arid regions, however, a component of discharge may occur during hyperarid episodes. Further validation of moisture composition using stable isotope techniques is required under such conditions. (See also W89-02223) (Author's abstract)
W89-02232

RECHARGE ESTIMATION FROM THE DEPTH-DISTRIBUTION OF ENVIRONMENTAL CHLORIDE IN THE UNSATURATED ZONE: WESTERN AUSTRALIAN EXAMPLES,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Groundwater Research.
M. L. Sharma.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 159-173, 5 fig, 26 ref.

Descriptors: *Groundwater recharge, *Chlorides, *Aeration zone, *Recharge, *Australia, Recharge, Mathematical equations, Estimating, Solute transport, Vertical flow, Groundwater movement, Model studies, Coastal aquifers, Rainfall.

Presented are methods for computing long-term, average recharge rates to groundwater from the analyses of the depth-distribution of environmental chloride in the unsaturated zone. A one-dimensional equation, incorporating convective and diffusion terms, describing steady-state transport of non-reactive solutes, is solved in an inverse fashion, enabling computation of the depth-distribution of vertical water flux density. This and other simplified models were applied to interpret the observed chloride profiles beneath native vegetation in two coastal regions of Western Australia. The presence of preferred pathways for water movement has been suggested for both regions. In the sandy coastal region, the overall recharge was some 15% of the annual precipitation (775 mm/yr). Over 50% of this recharge occurs through preferred pathways. In the profiles of the south-western region, the majority of recharge occurs through preferred pathways since the estimated recharge through the soil matrix is negligible (<0.5% annual rainfall). The limitations of using a simple one-dimensional model for such complex lateritic profiles are discussed. (See also W89-02223) (Author's abstract)
W89-02233

NATURAL RECHARGE MEASUREMENTS IN THE HARD ROCK REGIONS OF SEMI-ARID INDIA USING TRITIUM INJECTION - A REVIEW,
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).

For primary bibliographic entry see Field 7B.
W89-02234

COMPARISON OF RECHARGE ESTIMATES FROM INJECTED TRITIUM TECHNIQUE AND REGIONAL HYDROLOGICAL MODELLING IN THE CASE OF A GRANITIC BASIN IN SEMIARID INDIA,

National Geophysical Research Inst., Hyderabad (India).
D. Muralidhara, C. S. Murti, and R. N. Athavale.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 195-204, 3 fig, 1 tab, 4 ref.

Descriptors: *Tritium, *Hydrologic models, *Semiarid lands, *Tracers, *Recharge, *India, *Groundwater recharge, Aquifers, Monsoon, Precipitation, Soil water, Injection, Schist, Gneiss, Groundwater level, Mathematical studies, Case studies, Recharge.

The injected Tritium technique was used for estimation of recharge from 1978 monsoon precipitation to the phreatic aquifers of the West Survarnamukhi sub-basin, forming a part of the Vedavati basin and having an area of 958 sq km, covered with granite, gneisses, and schists. Recharge was measured at 20 sites, of which 6 were in schists and the rest in gneisses. Displacement of tritium tracer peak in the unsaturated Alfisol zone was used for measuring the spot values of recharge which varied from 0 mm to 127 mm. The average recharge calculated from spot values was found to be 39.2 mm or 8.5% of the seasonal rainfall. The input to the groundwater regime of the basin, calculated by using the Thiessen polygon method works out to be 43.8 million cu m (MCM). A regional groundwater model of the Vedavati basin has recently been prepared. Based on water level fluctuation data for the period November 1977 to November 1978, these authors have estimated the annual recharge for various parts of the Vedavati basin. The annual recharge or safe yield value for West-Survarnamukhi basin, obtainable from the model, is 42.5 mm. Thus, an agreement between recharge values estimated from tritium injection in the unsaturated zone, and from a model calibrated with water level fluctuations in the saturated zone is observed in the case of West Survarnamukhi basin. (See also W89-02223) (Author's abstract)
W89-02235

STUDIES ON NATURAL RECHARGE TO THE GROUNDWATER BY ISOTOPE TECHNIQUES IN ARID WESTERN RAJASTHAN, INDIA,

Indian Agricultural Research Inst., New Delhi. Nuclear Research Lab.
H. Chandrasekharan, S. V. Navada, S. K. Jain, S. M. Rao, and Y. P. Singh.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 205-220, 8 fig, 5 tab, 20 ref.

Descriptors: *Groundwater recharge, *Isotopic tracers, *Arid lands, *India, *Tracers, *Recharge, Groundwater potential, Tritium, Carbon radioisotopes, Hydrogen, Oxygen, Cobalt radioisotopes, Precipitation, Rainfall, Artesian wells, Aquifers.

Studies on natural recharge to the groundwater is an important parameter for careful assessment of groundwater potential in arid regions. In this paper, the use of both environmental (2-H, 18-O and 14-C) and artificial (3-H and 60-Co) isotopes in understanding the nature of recharge and recharge condition of groundwater in certain parts of arid Western Rajasthan are presented and discussed in the light of results of other investigations. The injected radiotracer studies show that most of the arid areas have very little contribution toward groundwater from local precipitation with few exceptions. The natural recharge in Siwana region worked out to about 1% of the rainfall from 1982 to 1985 and at Jodhpur it is around 13% of the rainfall from 1983 to 1985. The environmental isotope study shows that the artesian flowing well and other deep dug/tube wells have waters which are ancient and recharged during a more moist and cool period than the present. The deep wells were possibly recharged remotely through distant outcrop areas. The shallow and deeper aquifers appear to be interconnected as evidenced by their stable isotopic compositions. (See also W89-02223) (Lantz-PTT)
W89-02236

NUMERICAL AND CONCEPTUAL MODELS FOR RECHARGE ESTIMATION IN ARID AND SEMI-ARID ZONES,

Birmingham Univ. (England). Dept. of Civil Engineering.
K. R. Rushton.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 223-238, 5 fig, 18 ref.

Descriptors: *Mathematical models, *Model studies, *Groundwater recharge, *Recharge, *Semiarid lands, *Arid lands, Estimating, Soil water, Irrigation, Aeration zone, Runoff, Water table, Groundwater level, Recharge.

Recharge estimation can be based on a wide variety of models which are designed to represent the actual physical processes. This paper considers the direct estimation of recharge using soil moisture balance models, recharge due to losses from irrigation schemes, the influence of the unsaturated zone and recharge due to rivers and other sources of runoff. A study of the water table fluctuation method indicates that indirect methods often provide unreliable estimates. Several examples are included to demonstrate that, by identifying and representing the flow mechanisms, realistic estimates of recharge can be made. (See also W89-02223) (Author's abstract)
W89-02237

METHODS FOR ESTIMATION OF NATURAL GROUNDWATER RECHARGE DIRECTLY FROM PRECIPITATION - COMPARATIVE STUDIES IN SANDY TILL,

Royal Inst. of Tech., Stockholm (Sweden). Institutionen foer Kulturteknik.
P.-O. Johansson.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 239-270, 16 fig, 3 tab, 38 ref.

Descriptors: *Groundwater recharge, *Precipitation, *Comparison studies, *Recharge, *Soil water, *Infiltration, *Glacial soils, *Tracers, Sand, Estimating, Sweden, Groundwater movement, Groundwater level, Evapotranspiration, Chlorides, Model studies, Mathematical studies.

Six different methods for estimation of natural groundwater recharge directly from precipitation were tested and compared in a sandy till area in southeastern Sweden. A one dimensional soil water flow model was tested against observed groundwater levels. The fit between simulated and observed groundwater levels was shown to be rather insensitive to displacements between evapotranspiration and groundwater recharge. Applying a single soil moisture reservoir method, recharge had to be allowed even when a moisture deficit existed in order to correctly reproduce the dynamics revealed as groundwater level fluctuations. The estimation made from groundwater level fluctuations and a specific yield value was not satisfactory. Comparisons of chloride deposition and concentration in spring discharge gave promising results for studies of relative areal variability of recharge. Spring discharge measurements and a catchment area model, calibrated against them, gave valuable information of total recharge quantities, which could be used for comparisons with the other methods. The study clearly demonstrated the need for comparative studies with several methods, since all estimations suffered from substantial uncertainty. (See also W89-02223) (Author's abstract)
W89-02238

PRINCIPLES OF INVERSE MODELLING FOR ESTIMATION OF RECHARGE FROM HYDRAULIC HEAD,

Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Groundwater Research.
H. Allison.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 271-282, 19 ref.

Descriptors: *Groundwater recharge, *Inverse modeling, *Hydraulic head, *Recharge, *Mathematical modeling, *Model studies, Estimating, Boussinesq equation, Mathematical studies, Groundwater movement.

The Boussinesq equation permits, in principle, estimation of recharge for steady groundwater flow by taking derivatives of hydraulic head and transmissivity functions. The obstacles for doing this are as follows. Taking derivatives of the spatially-distributed data, even when they are known at every point, leads to numerical instability. Hydraulic heads are always measured with inaccuracies. Differentiating this 'noisy' data leads to large errors in recharge estimation. It is shown that by using a special modification of the Boussinesq equation it is possible to overcome all three difficulties simultaneously. (See also W89-02223) (Lantz-PTT)
W89-02239

ESTIMATING NATURAL RECHARGE OF GROUND WATER BY MOISTURE ACCOUNTING AND CONVOLUTION,

Orange Free State Univ., Bloemfontein (South Africa). Inst. vir Grondwaterstudies.
J. Willemink.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 283-299, 4 fig, 10 ref.

Descriptors: *Groundwater recharge, *Model studies, *Recharge, *Routing, Mathematical models, Estimating, Rainfall, Water table, Groundwater level, Aquifers.

A numerical model has been developed for calculating the groundwater recharge at areas with or without a thin soil cover (up to 20 cm) underlain by hard- rock formations. The system is simulated by hydrologic routing through a number of serially arranged linear reservoirs. The point rainfall is being converted, by daily moisture accounting, into effective rainfall. This, in turn, is being converted into the water table response by the convolution operation. The unknown model parameters are calibrated, using an automatic optimization procedure based on the criterion to minimize the error differences between the recorded water table recovery and the simulated one. The minimum required input data are daily readings of the water table in an observation well, near the topographic water divide (or just downstream an aquifuge), and daily rainfall figures from a rain gauge close to the well. The proposed model has been applied to a site in the central part of South Africa with promising results. (See also W89-02223) (Author's abstract)
W89-02240

NATURAL GROUND WATER ESTIMATION METHODOLOGIES IN INDIA,

Central Ground Water Board, New Delhi (India).
B. P. C. Sinha, and S. K. Sharma.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 301-311, 3 tab, 6 ref.

Descriptors: *Groundwater recharge, *India, *Recharge, Estimating, Mathematical studies, Hydrologic budget, Groundwater level, Fluctuations.

Groundwater is one of the most important and widely distributed resources of the earth. Groundwater development forms the bulk of irrigation development programs in most of the states of India. For planned development of groundwater resources it becomes essential to quantify the

groundwater resources of different administrative units/basins on a realistic basis. Since groundwater is a dynamic and replenishable resource, its potential is generally estimated from the component of annual recharge which could be developed by means of suitable groundwater structures. The natural recharge to an aquifer in a groundwater basin from precipitation is computed by various methods. Some of the methods in vogue in India are: (1) empirical methods; (2) hydrologic budgeting methods; and (3) groundwater level fluctuations. Each of these methods is discussed in this paper. (See also W89-02223) (Lantz-PTT)
W89-02241

BALSEQ - A MODEL FOR THE ESTIMATING OF WATER BALANCES, INCLUDING AQUIFER RECHARGES, REQUIRING SCARCE HYDROLOGIC DATA,
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
J. P. L. Ferreira, and J. D. Rodrigues.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 313-319, 1 fig, 3 ref.

Descriptors: *BALSEQ model, *Model studies, *Hydrologic budget, Recharge, *Aquifers, *Groundwater recharge, Estimating, Portugal, Mathematical models, Precipitation, Runoff, Evapotranspiration, Soil water.

A mathematical model for the estimation of daily sequential water balances is presented. The following hydrologic variables are updated daily by the model: precipitation runoff, evapotranspiration, soil moisture and deep recharge of aquifers. The model was used with good results in the study of water resources of several Portuguese watersheds. The results obtained with this model are however highly dependent on the values ascribed to the calculation of the weighted runoff curve number and the amount of water necessary to increase the soil moisture of the evapotranspiration zone from its lower-most value to the specific retention of the soil, which have a difficult calibration procedure. Experience gathered with the use of this model shows that very precise results should not be expected from its use. However, the existence of an acceptable range of values for runoff and aquifer recharge may be very useful in water resources evaluation, when only scarce hydrologic and geohydrologic data are available. Computed values, even when they cannot be used directly as definite results, may be used as geohydrologic tools in the overall assessment of recharge conditions. (See also W89-02223) (Lantz-PTT)
W89-02242

QUANTIFICATION OF GROUNDWATER RECHARGE IN ARID REGIONS: A PRACTICAL VIEW FOR RESOURCE DEVELOPMENT AND MANAGEMENT,
British Geological Survey, Wallingford (England).
S. S. D. Foster.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 323-338, 11 fig, 1 tab.

Descriptors: *Groundwater recharge, *Arid lands, *Water resources development, *Recharge, *Groundwater management, Botswana, Peru, Geohydrology, Model studies, Developing countries.

Where the geohydrological database and project constraints permit, the application of various independent physical and chemical methods is likely to be the best way to improve knowledge of aquifer recharge mechanisms and rates. The selection of techniques depends mainly on the geohydrological environment, vegetation system, and on whether diffuse or localized recharge is likely to predominate. The critical use of aquifer numerical distributed-parameter models will normally be the most powerful and comprehensive method of improving recharge estimates. Such models also allow appraisal of the sensitivity of groundwater development options and management decisions to errors in the estimation of aquifer recharge rates and storage parameters, which is an essential procedure. In many instances, especially in developing nations, there are inadequate data, particularly on the aquifer response to groundwater abstraction, to reach adequate model calibration. However, in most cases, if a flexible approach to project design or management strategy is adopted, the necessary data can be collected within the operation of normal groundwater production provided a suitable observation borehole network is installed. It is important to consider the quality of present groundwater recharge, as well as its quantity, and the radical modifications to the groundwater recharge regime which often occur in arid regions consequent upon agricultural development or urbanization. (See also W89-02223) (Lantz-PTT)
W89-02243

GROUNDWATER RECHARGE STUDIES IN SEMI-ARID BOTSWANA: A REVIEW,
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
J. J. de Vries, and M. von Hoyer.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 339-347, 1 fig, 13 ref.

Descriptors: *Groundwater recharge, *Semiarid lands, *Botswana, *Literature review, *Recharge, *Geohydrology, Aquifers, Rocks, Sedimentary rocks, Crystalline rocks, Mass balance, Isotopic tracers.

Some 80% of the surface of Botswana is mantled with thick layers of Late-Cretaceous to Recent sandy deposits of the Kalahari semi-desert. Sedimentary and crystalline rocks of pre-Cretaceous age occur at or near the surface in the remaining eastern part of the country. Groundwater basins have been encountered in the bedrock below the Kalahari deposits all over the area, but no unanimity has been reached on the question of the existence of any present-day recharge. Replenishment of the aquifers in the outcrop areas of solid rocks is not disputed, but no reliable figures on the percolation rate could be established as yet. The various investigations and methods applied in recharge studies in Botswana - including mass balance methods and isotope studies - are reviewed. (See also W89-02223) (Author's abstract)
W89-02244

RAINFALL - RUNOFF - RECHARGE RELATIONSHIPS IN THE BASEMENT ROCKS OF ZIMBABWE,
Hydrotechnica, Shrewsbury (England).
For primary bibliographic entry see Field 2B.
W89-02245

RECHARGE CHARACTERISTICS OF AQUIFERS OF JEDDAH-MAKKAH-TAIF REGION,
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Civil Engineering.
Y. Basmaci, and M. Al-Kabir.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 367-375, 3 fig, 1 tab, 5 ref.

Descriptors: *Aquifers, *Groundwater recharge, *Jeddah-Makkah Taif, *Recharge, *Tracers, *Surface-groundwater relations, Saudi Arabia, Isotopic tracers, Oxygen, Deuterium, Tritium, Rainfall.

Recharge characteristics of the aquifers over the Jeddah-Makkah-Taif region of the Western Saudi Arabia were studied through environmental isotope techniques. Space and time variation of oxygen-18, deuterium and tritium in rainfall and in groundwater were analyzed. Variation of oxygen-18 with respect to the altitude in rain and groundwater are expressed as deltaO to the 18th = -4h + b and deltaO to the 18th = -1.4h - 0.70 respectively. The intercept of the regression equation for rain samples varies in a range of -2 to 8 parts per thousand O to the 18th indicating seasonal changes and multitude of moisture sources in the area. The recharge area is the mountainous zone. Recharge is either direct or from the floods moving to the downstream reaches. (See also W89-02223) (Author's abstract)
W89-02246

GROUNDWATER RECHARGE AND SUBSURFACE FLOW IN THE COMODORO RIVADAVIA AREA, CHUBUT PROVINCE, ARGENTINA: ISOTOPIC AND HYDROCHEMICAL STUDY,
Instituto de Geocronologia y Geologia Isotopica, Buenos Aires (Argentina).
M. Levin, H. O. Panarello, M. C. Albero, E. Castrillo, and M. Grizinik.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 377-393, 5 fig, 3 tab, 6 ref.

Descriptors: *Groundwater recharge, *Groundwater movement, *Argentina, *Recharge, *Tracers, *Isotopic tracers, *Chemical analysis, Oxygen radioisotopes, Deuterium, Tritium, Snowmelt, Recharge, Flow profiles.

Groundwater in the Comodoro Rivadavia area was studied using oxygen-18, deuterium, tritium and hydrochemical evolution. Stable isotopes in the multilayered system of the 'pampa' table - lands define mainly an origin in locally melted snow with isotope composition significantly different from rain water over the lower eastern zones. Recharge has been defined as direct and autochthonous. Tritium contents suggest rather small recharge in comparison with the large volume stored in the reservoir. In the neighboring hill zone, where discharge occurs, springs and wells show isotopic evidence of local flow. In the interhill subunit, regional flow shows salinization and isotopic enrichment as a consequence of transit through marine facies and evaporation. In colluvial sediments groundwater exhibits higher tritium concentration, lower salinity and an isotope enrichment, due to direct infiltration of local surface water. Allochthonous-to-local recharge ratios can be estimated by the isotopic composition of the mixture. In the beach ridges, regional flow and artificial recharge of imported waters, carried by an aqueduct, was isotopically evident. (See also W89-02223) (Author's abstract)
W89-02247

GROUNDWATER RECHARGE OVER WESTERN SAUDI ARABIA,
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Civil Engineering.
Y. Basmaci, and J. A. A. Hussein.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 395-403, 3 fig, 1 tab, 11 ref.

Descriptors: *Groundwater recharge, *Saudi Arabia, *Recharge, Aquifers, Semiarid lands, Rainfall, Catchment basins, Floods.

Recharge characteristics of the groundwater aquifers over the western Saudi Arabia were investigated. Average yield of each aquifer was proportional to that part of the catchment which lay in the semiarid zone. Recharge came directly from rain over outcropping rocks and the basalt plateau and resulted from floods in the alluvial aquifers. Pediment zones intercepted much of the runoff. (See also W89-02223) (Author's abstract)
W89-02248

NATURAL RECHARGE OF KARST AQUIFERS IN WESTERN TAURUS REGION (SOUTHWESTERN TURKEY),
Hacettepe Univ., Ankara (Turkey). Dept. of Hydrogeological Engineering.
G. Gunay.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 405-422, 7 fig, 4 tab, 17 ref. United Nations Development Program Project TUR/81/004.

Descriptors: *Karst, *Aquifers, *Groundwater recharge, *Turkey, *Recharge, *Karst hydrology, *Geohydrology, Hydrologic budget, Taurus mountains.

In the Western Taurus region that extends between the Lake District and the Mediterranean Sea, South-western Turkey, some of the largest karst aquifers in the world are to be bound. These are, from east to west, namely, the karst aquifers of the Manavgat river basin, the Kopprucay river basin, the Aksu river basin and karst aquifers of the travertines of the Antalya plateau and the Kirkgoz Springs. Computation of recharge and discharge of the above listed aquifers has been made during the intensive and detailed geohydrological investigation of the relevant basins. These water balance computations showed significant contribution by natural recharge from adjacent basins. In order to reach a higher degree of accuracy, the sources of errors must be analyzed before interpreting. The natural recharge in the southwestern Taurus Mountains region reaches up to 100 million cu m/yr. Construction of geohydrotechnical projects must be planned taking into account both the natural recharge and the area that provides this excess water. It is concluded that computations of water balance and consequently the natural recharge must reach a higher accuracy and new approaches and methods with well defined parameters. (See also W89-02223) (Lantz-PTT)
W89-02249

ESTIMATION OF RECHARGE OF SAND AQUIFER OF THE ISLAND OF MANNAR, SRI LANKA,

Moratuwa Univ. (Sri Lanka). Dept. of Civil Engineering.
D. C. H. Senarath.

IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 423-434, 3 fig, 1 tab, 10 ref.

Descriptors: *Groundwater recharge, *Hydrologic budget, *Aquifers, *Mannar Island, *Recharge, Sri Lanka, Estimating, Stream flow, Model studies.

An estimation of recharge to an aquifer can be carried out on the basis of water balance in which the top surface of the catchment and the soil moisture zone are taken into account. The data required are daily precipitation and potential evapotranspiration. The water balance can be verified on the basis of comparison of estimated stream flow with measured stream flow. The method is illustrated by application to estimation of the recharge to a sand aquifer situated in the island of Mannar in north-west Sri Lanka. When the recharge is correctly estimated, the quantitative resources of the aquifer can be evaluated and a scheme can be drawn up for its utilization. Further information regarding the behavior of the aquifer would emerge during the initial stages of its utilization as more data becomes available. The estimates of recharge as obtained by the method used in this study can be confirmed by a flow model of the aquifer whose results can be verified by comparison with field data such as groundwater head distribution in space and time. The method used in this study also will give monthly or daily values of recharge. (See also W89-02223) (Lantz-PTT)
W89-02250

GROUNDWATER RECHARGE FROM THREE CHEAP AND INDEPENDENT METHODS IN THE SMALL WATERSHEDS OF THE RAIN FOREST BELT OF NIGERIA,

Nigeria Univ., Nsukka. Dept. of Geology.
K. O. Uma, and B. C. E. Egboka.

IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 435-447, 2 fig, 4 tab, 10 ref.

Descriptors: *Groundwater recharge, *Recharge, *Hydrologic budget, *Recession curve, *Rain forests, *Nigeria, Estimating, Mathematical equations, Recharge, Recession analysis, Hydrologic budget, Rainfall, Data interpretation.

A study to critically and comparatively evaluate groundwater recharge into the small watersheds of the Imo River Basin, Nigeria, using three independent but cheap methods, is discussed. The methods include: groundwater recharge using a simplified equation that relates groundwater stage to actual recharge with the aid of the aquifer porosity; recharge from baseflow recession analysis; and recharge from a water balance method. The results show that recharge values obtained from the water balance method were consistently higher than values from the other methods and ranged from 13.15% to 43.19% of the annual rainfall. Values obtained from baseflow recession analysis were consistently lower and ranged from 10.86% to 28.59%, while the values computed from the groundwater stage were moderate and ranged from 20.67% to 37.23% of the annual rainfall in the watersheds. The recharge values obtained from the groundwater stage appear very reasonable. However, the method is affected by the local relief of the monitoring station and it is necessary to monitor at as many stations as are possible to increase the reliability of the results. The recharge values obtained from the different methods show good correlation with one another. In the absence of groundwater stage data, recharge may be satisfactorily estimated as the mean of the values obtained from the baseflow recession analysis and the water balance methods. (See also W89-02223) (Author's abstract)
W89-02251

QUANTITATIVE ESTIMATION OF GROUNDWATER RECHARGE IN DOLOMITE,

Department of Water Affairs, Forestry and Environmental Conservation, Pretoria (South Africa).
D. B. Bredenkamp.

IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 449-460, 7 fig, 5 tab, 10 ref.

Descriptors: *Groundwater recharge, *Dolomite, *Quantitative analysis, *South Africa, *Recharge, Mathematical analysis, mathematical equation, Annual recharge, Annual rainfall, Rainfall, Hydrographs, Hydrologic budget.

Quantitative estimation of annual recharge in the Bo Molopo dolomitic region (Western Transvaal) by means of the following equation, is demonstrated with a great measure of success: RE(I) = A(RF(I) -B), where RE(I) is the annual recharge and RF(I) the annual precipitation. B represents the threshold rainfall that is required to effect recharge and A is a lumped catchment parameter. Values for A (ranging from 0,28 to 0,35) and for B (ranging from 310 to 360) were obtained using reference recharge values that were determined: from an interpretation of a sinkhole hydrograph; from water balance calculations. In checking the validity of the equation to estimate the average annual recharge RE, using the average annual rainfall in different dolomitic areas, the following relationship provided excellent results (correlation coefficient of 0, 989): RE = 0,30 (RF - 313) where RF is the average annual rainfall. The latter equation is regarded as the general relationship by which both annual and average recharge could be estimated for dolomitic regions in the summer rainfall areas of South Africa. (See also W89-02223) (Author's abstract)
W89-02252

QUANTITATIVE ESTIMATION OF GROUNDWATER RECHARGE IN THE PRETORIA-RIETONDALE AREA,

Department of Water Affairs, Forestry and Environmental Conservation, Pretoria (South Africa).
D. B. Bredenkamp.

IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 461-476, 5 fig, 7 tab, 3 ref.

Descriptors: *Hydrographs, *Tracers, *Recharge, *Groundwater recharge, *Pretoria, Rietondale, South Africa, Groundwater level, Tritium, Data interpretation, Boreholes, Monitoring, Aquifers, Porosity, Precipitation, Annual recharge, Annual rainfall, Mathematical equations

Annual values of groundwater recharge expressed as an effective water-level rise were derived from an interpretation of the hydrographs of three monitoring boreholes. Independent estimates of the average annual recharge of the area were derived by means of the Darcy equation and by interpretations of natural tritium profiles in the soil overburden. The effective porosity of the aquifer was calculated from the average annual recharge (66 mm) and the average rise of the water level derived from the hydrographs. This effective porosity (0, 0093) was used to convert the annual equivalent water-level rises to a depth of precipitation. The latter were plotted against annual rainfall and indicates a linear relationship with annual rainfall in excess of a threshold value i.e. RE(I) = A (RF(I) -B) where RE(I) is the recharge and RF(I) the rainfall for the year I. B is the threshold rainfall with an average value of 395 mm and the coefficient A is a lumped catchment parameter indicating the fraction of the excess annual rainfall that represents recharge. For the Rietondale area A is about 0, 20 which implies that 20% of the excess rainfall constitutes recharge. The equation is similar to that obtained in the Bo Molopo dolomite area but in that case A is 0, 30 and B is 313 mm. (See also W89-02223) (Author's abstract)
W89-02253

ANALYSIS OF LONG-DURATION PIEZOMETRIC RECORDS FROM BURKINA FASO USED TO DETERMINE AQUIFER RECHARGE,

Bureau de Recherches Geologiques et Minieres, Orleans (France).
D. Thiery.

IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 477-489, 10 fig, 6 ref.

Descriptors: *Data interpretation, *Aquifers, *Burkina Faso, *Piezometry, *Recharge, *Hydrologic budget, *Groundwater recharge, Observation wells, Groundwater level, Hydrologic models, Rainfall, Evapotranspiration, Calibration, Surface runoff, Recharge.

An 8-year water-level record for an observation well in a granite environment in Ouagadougou (Burkina Faso) is analyzed using a lumped-parameter hydrological model. The model computes aquifer levels from rainfall and potential evapotranspiration data, and is calibrated with observed levels. Very satisfactory calibration is achieved, although aquifer levels have been dramatically declining since 1978. It appears that, even with small computational time-steps, a unique solution for calibration is only possible if the precise storage coefficient is known or if surface runoff data are available. In the absence of such data, multiple calibrations displaying the same agreement with observed data give different values for aquifer recharge, although relative variation is the same from year to year. When used in conjunction with a long set of in-situ rainfall records, however, the various sets of parameters applied result in almost-identical extension of water-level data, an important advance. The models how that the 1978-1985 is period is typified by the lowest water levels encountered in at least 60 years, and that a return to a rainfall sequence near the long-term average would cause the level to rise, although only after a period of 7 to 10 years. (See also W89-02223) (Author's abstract)
W89-02254

HUMID AND ARID ZONE GROUNDWATER RECHARGE - A COMPARATIVE ANALYSIS,

Bureau de Recherches Geologiques et Minieres, Orleans (France).
G. Knutsson.

IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 493-504, 6 fig, 18 ref.

Descriptors: *Groundwater recharge, *Humid areas, *Arid lands, *Recharge, *Hydrologic budget, Recharge, Aquifers, Wadi, River valleys,

Comparison studies, Aeration zone, Precipitation, Evapotranspiration, Groundwater movement, Leaching.

Humid climates - contrary to arid climates - are characterized by higher precipitation than evapotranspiration. This means that water balance methods for estimation of groundwater recharge are more useful in humid than in arid climates. Groundwater recharge in humid climates takes place more or less continuously by percolation in the unsaturated zone in the higher parts of the terrain and the water is discharged in the lower parts. This is contrary to the conditions in the arid climates, where the input of water is intermittent and the recharge is mainly localized to the lower parts of the terrain (river valleys, wadis) and rock outcrops. The unsaturated part of the ground with its vegetation is the crucial zone. THe dominating water movement is downward in humid climates with leaching and weathering, contrary to in arid climates, where there is an upward transport and enrichment of salts. The methods for estimation of groundwater recharge based on soil water balance or soil water flow are more important in humid than in arid climates. (See also W89-02223) (Author's abstract)
W89-02255

DESIGN AND CONSTRUCTION OF WATER WELLS: A GUIDE FOR ENGINEERS,
National Water Well Association, Worthington, OH.
For primary bibliographic entry see Field 8A.
W89-02256

2G. Water In Soils

MODEL FOR INFILTRATION IN FROZEN SOILS THAT ACCOUNTS FOR WATER QUALITY (UN MODELE POUR L'INFILTRATION DANS LES SOLS GELES TENANT COMPTE DE LA QUALITE DE L'EAU),
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec). Centre de l'Energie.
F. Padilla, and P. Gelinas.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 2, p 263-274, April 1988. 8 fig, 60 ref. English summary.

Descriptors: *Soil water, *Frozen soils, *Ground ice, *Infiltration, *Heat transport, *Solute transport, Stefan problem, Finite element method, Mathematical models, Simulation analysis, Aeration zone, Frost heaving, Flow discharge.

The problems of infiltration of water and movement of solutes in frozen soils were solved using finite element methods for the numerical solution of water flow, heat flow, and solute movement transport in one dimension. These equations are coupled for the solution of Stefan's problem for different conditions of ice in soils. The degrees of freedom of this problem are soil temperature, water pressure, and solute concentration. A model was proposed to simulate the presence and formation of ice lenses in unsaturated and saturated soils. Early results are promising when compared to analytical solutions. Two extreme cases were considered in applications: very wet and very dry soils. Frost heave and other parameters seem to have been properly simulated. The model considers special phenomena related to colloidal soils; nevertheless, a comparison with field data is required. (Author's abstract)
W89-01339

HYDROLOGIC FACTORS TRIGGERING A SHALLOW HILLSLOPE FAILURE,
California Univ., Santa Cruz. Dept. of Earth Sciences.
M. E. Reid, H. P. Nielsen, and S. J. Dreiss.
Bulletin of the Association of Engineering Geologists AEGBBU, Vol. 25, No. 3, p 349-361, August 1988. 12 fig, 2 tab, 34 ref.

Descriptors: *Land slides, *Slope degradation, *Hydraulic gradient, *Mathematical models, *Saturated flow, Rainstorms, Precipitation, Rainfall, Storms, Water level, Groundwater level, Water table, Perched water table, Model studies, Flow, Hydraulic conductivity, Mass wasting, Hydrology.

In February 1983, an intense rainstorm triggered a shallow, rapid slump/debris-flow on a monitored hillslope of coastal central California. Discontinuous records of rainfall and maximum groundwater levels within the slide mass were collected before and after the event. These water levels show the development of a shallow perched water table in soil overlying an older, low permeability landslide deposit. Although this perched water table had an overall downslope hydraulic gradient, the slope failure occurred in an area of localized gradient decrease or mounding. The cause of this localized mounding was not apparent from field observations. A mathematical model of variably saturated water flow was used to investigate the pre-failure hillslope hydrology and to demonstrate a possible cause of the localized groundwater build-up. Simulations indicate that only a slight decrease in soil hydraulic conductivity, relative to the overall soil variability, would have been needed to create the observed build-up. (Author's abstract)
W89-01363

ENHANCED BIORECLAMATION, SOIL VENTING AND GROUND-WATER EXTRACTION: A COST-EFFECTIVENESS AND FEASIBILITY COMPARISON,
EA Engineering, Science, and Technology, Inc., Lafayette, CA.
For primary bibliographic entry see Field 5G.
W89-01540

MULTI DEPTH SOIL GAS ANALYSES,
San Diego State Univ., CA. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5A.
W89-01550

SOIL GAS SURVEY AS A PRELIMINARY INVESTIGATIVE TOOL FOR HYDROCARBON RELEASES: COST-EFFECTIVE FIELD TECHNIQUES AND AN EVALUATION OF FACTORS INFLUENCING THE EFFECTIVENESS OF THE SURVEY,
IEP, Inc., Northborough, MA.
For primary bibliographic entry see Field 5A.
W89-01551

LABORATORY SETUP TO STUDY TWO-DIMENSIONAL MULTIPHASE FLOW IN POROUS MEDIA,
American Society for Engineering Education, Washington, DC.
For primary bibliographic entry see Field 5B.
W89-01553

SORPTION AND MIGRATION OF ORGANIC CONTAMINANTS IN SOIL COLUMN,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5B.
W89-01554

MASS TRANSFER OF ORGANICS BETWEEN SOIL, WATER AND VAPOR PHASES: IMPLICATIONS FOR MONITORING, BIODEGRADATION AND REMEDIATION,
Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5B.
W89-01559

INFLUENCE OF PORE AIR/WATER EXCHANGE ON THE DIFFUSION OF VOLATILE ORGANIC VAPORS IN SOIL,
Connecticut Univ., Storrs. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 5B.
W89-01560

VADOSE MODEL OF GASOLINE LEAK,
Insitu Consulting, Laramie, WY.
For primary bibliographic entry see Field 5B.
W89-01561

ESTIMATES OF CONCENTRATIONS OF SOLUBLE PETROLEUM HYDROCARBONS MIGRATING INTO GROUND WATER FROM CONTAMINATED SOIL SOURCES,
New Jersey Dept. of Environmental Protection, Trenton. Div. of Hazardous Site Migration.
For primary bibliographic entry see Field 5B.
W89-01562

PENTACHLOROPHENOL ADSORPTION ON SOILS AND ITS POTENTIAL FOR MIGRATION INTO GROUND WATER,
Missouri Univ., Columbia. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-01642

INTERACTION OF CLAY AND INDUSTRIAL WASTE: A SUMMARY REVIEW,
McGill Univ., Montreal (Quebec). Geotechnical Research Centre.
For primary bibliographic entry see Field 5B.
W89-01663

MIGRATION OF ORGANIC FLUIDS IMMISCIBLE WITH WATER IN THE UNSATURATED AND SATURATED ZONES,
Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W89-01665

CONCEPT OF EFFECTIVE POROSITY AND ITS MEASUREMENT IN SATURATED FINE-GRAINED POROUS MATERIALS,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2F.
W89-01672

RESEARCH ON INTERCEPTION LOSSES AND SOIL MOISTURE RELATIONSHIPS,
Northeastern Forest Experiment Station, Parsons, WV. Timber and Watershed Lab.
For primary bibliographic entry see Field 2A.
W89-01700

SOIL ARTHROPODS AND THEIR ROLE IN DECOMPOSITION AND MINERALIZATION PROCESSES,
Kansas State Univ., Manhattan. Div. of Biology.
T. R. Seastedt, and D. A. Crossley.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 233-243, 3 fig, 3 tab.

Descriptors: *Ecosystems, *Soil environment, *Decomposition, *Litter, *Mineralization, *Arthropods, Lignin, Carbon, Nitrogen, Phosphorus, Detritus.

Studies at Coweeta suggest that litter and soil arthropods are directly and indirectly responsible for a 20% to 40% increase in the cycling rates of most elements. The mechanisms responsible for these increased mineralization rates remain poorly known. It is not known if the net faunal effect is due to more efficient processing of nutrients by a continually cropped (hence, younger and more physiologically active) microflora, or if the response is primarily caused by a shift in the species composition of the microflora. An untested assumption is made that the faunal effects measured in the short-term studies can be extrapolated using standard exponential decay models. It was suggested that decomposition apparently ceases when the ratio of lignin to lignin plus cellulose approaches a given value; a physical mixing or some other process that reduces overall lignin content of a substrate must occur. Research at the ecosystem level has indicted that the ratios of important elements such as C:N:P ratios may result in certain predict-

able patterns of energy allocation by plants. These patterns have subsequent consequences to consumers. Herbivores appear to both respond to plant C/N ratios, and also cause changes that influence other consumers. A similar process also occurs within the detrital food web. Feeding activities of soil fauna produce measurable changes in the chemical content of the detritus, and this chemically modified material influences the subsequent activities of detritivores and microbivores. At any given time, a system or subsystem such as the forest floor may therefore be represented by a nutrient and energy matrix that, free from extrinsic perturbation, will interact with the microclimate and generate a subsequent matrix. The soil arthropod fauna at Coweeta represents a major factor in the regulation of this nutrient and energy reservoir. Continued studies of soil invertebrates at Coweeta will undoubtedly contribute to the knowledge of these emerging patterns. (See also W89-01691) (Lantz-PTT)
W89-01702

VADOSE ZONE MODELING OF ORGANIC POLLUTANTS.
For primary bibliographic entry see Field 5B.
W89-01859

OVERVIEW OF TERRESTRIAL PROCESSES AND MODELING,
Aqua Terra Consultants, Palo Alto, CA.
For primary bibliographic entry see Field 5B.
W89-01860

TRANSPORT MECHANISMS AND LOSS PATHWAYS FOR CHEMICALS IN SOIL,
California Univ., Riverside.
For primary bibliographic entry see Field 5B.
W89-01861

GENERIC STEPS IN THE FIELD VALIDATION OF VADOSE ZONE FATE AND TRANSPORT MODELS,
Environmental Protection Agency, Las Vegas, NV.
For primary bibliographic entry see Field 7C.
W89-01862

EXAMPLE FIELD TESTING OF SOIL FATE AND TRANSPORT MODEL, PRZM, DOUGHERTY PLAIN, GEORGIA,
Environmental Protection Agency, Las Vegas, NV.
For primary bibliographic entry see Field 5B.
W89-01863

EXAMPLE MODEL TESTING STUDIES,
Aqua Terra Consultants, Palo Alto, CA.
For primary bibliographic entry see Field 7C.
W89-01864

CHEMICAL MOVEMENT THROUGH SOIL,
California Univ., Riverside.
For primary bibliographic entry see Field 5B.
W89-01865

VOLATILIZATION FROM SOIL,
California Univ., Riverside.
For primary bibliographic entry see Field 5B.
W89-01866

ADSORPTION OF ORGANIC CHEMICALS ONTO SOIL,
California Univ., Riverside.
For primary bibliographic entry see Field 5B.
W89-01867

BIOTRANSFORMATION,
Iowa Univ., Iowa City.
For primary bibliographic entry see Field 5B.
W89-01868

NONBIOLOGICAL TRANSFORMATION,
Iowa Univ., Iowa City.
For primary bibliographic entry see Field 5B.
W89-01869

SPATIAL VARIABILITY OF SOIL PROPERTIES,
California Univ., Riverside.
W. A. Jury.
IN: Vadose Zone Modeling of Organic Pollutants. Lewis Publishers, Inc., Chelsea, Michigan. 1986. p 245-269, 7 tab, 60 ref.

Descriptors: *Spatial variation, *Soil properties, *Soil water, *Soil mechanics, Model studies, Solute transport, Flow patterns, Distribution patterns, Mathematical studies, Stochastic process.

Soils vary significantly from point to point in their structural properties, textural composition, and mineralogical constituents. As a result, virtually all of the parameters characterizing the transport processes discussed in this report vary both laterally and vertically in an undisturbed soil profile of field size. Consequently, in the field setting, the task of modeling becomes considerably more complex than for laboratory scale processes. Characterization of the spatial variability of a parameter is not completely straightforward. The traditional approach is to assume that all replicated measurements of the property are statistically independent and to represent the property variation by specifying its sample mean and sample variance or coefficient of variation. Two distinct philosophies are currently in evidence in the ongoing research dealing with spatial variability. The first approach, called geometric scaling theory, uses certain standardized variables to scale the differential equations describing transport and relates the standardized variables to some measurable or definable property of each local site of a heterogeneous field. The second hypothesis for treating spatial variability is to regard the various parameters relevant to a field-wide description of transport as random variables characterized by a mean value and a randomly fluctuating stochastic component. A sampling at a point thus reveals a single momentary snapshot of these fluctuating properties which may be analyzed by statistical techniques designed to detect spatial correlations in order to yield information about the spatial distribution of the statistical fluctuations. This chapter discussion begins with a description of the known experimental information characterizing the extent of variability of key soil water and solute parameters. Next, the experimental evidence in support of the two key statistical models, scaling theory and regionalized variable analysis, will be discussed and summarized. Finally, the implications of spatial variability on parameter measurement will be analyzed using both the assumption of statistical independence and the assumption of statistical dependence. (See also W89-01859) (Lantz-PTT)
W89-01870

SORPTION OF 2,4-DICHLOROPHENOL AND 1,1,1-TRICHLOROETHANE ONTO THREE SOILS,
Rutgers - The State Univ., Piscataway, NJ. Dept. of Chemical and Biochemical Engineering.
For primary bibliographic entry see Field 5B.
W89-02082

METHODS FOR ESTIMATION OF NATURAL GROUNDWATER RECHARGE DIRECTLY FROM PRECIPITATION - COMPARATIVE STUDIES IN SANDY TILL,
Royal Inst. of Tech., Stockholm (Sweden). Institutionen foer Kulturteknik.
For primary bibliographic entry see Field 2F.
W89-02238

NODAL DOMAIN INTEGRATION MODEL OF TWO-DIMENSIONAL HEAT AND SOIL-WATER FLOW COUPLED BY SOIL-WATER PHASE CHANGE,
Williamson and Schmid, Irvine, CA.
T. Hromadka.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A183 518. Price codes: A06 in paper copy, A01 in microfiche. Special Report 87-9, June 1987. 124p, 33 fig, append.

Descriptors: *Frost, *Model studies, *Soil water, *Freezing, *Groundwater movement, *Heat, Mathematical studies, Freeze-thaw tests, Soil temperature, Computer models, Soil dynamics.

A model of phase change in freezing and thawing soils is developed for cold regions engineering problems which require two-dimensional analysis of the thermal regime of soils. These problems include complex boundary conditions such as atmosphere/ground surface thermal interaction and snowpack insulation. Other concerns include complex soil conditions such as the presence of a peaty muskeg or tundra-like soil which may provide thermal insulation for underlying muskeg or tundra-like soil which may provide thermal insulation for underlying ice-rich mineral soil. Although several models have been developed to predict temperatures in freezing and thawing soils, often the key question is simply whether or not the soil is frozen, since soil structural properties are significantly influenced by the soil water state of phase. In this report, a simple two-dimensional model is developed for use in cold regions engineering studies. A FORTRAN computer program is available which accommodates two-dimensional heat and soil water flow models as coupled by an isothermal phase change model. The program can be used to analyze two-dimensional freezing-thawing problems which have sufficient known information to supply the necessary modeling parameters, boundary conditions, and initial conditions. Because of the sophistication of the two-dimensional phase change model and the data requirements needed to properly represent inhomogeneity of the system, boundary conditions, and other complexities, a special data input program is developed in order to aid the model user. This general purpose data preparation program, PROTO0, develops the data input file to be used directly by the two-dimensional phase change program. (Author's abstract)
W89-02265

TRACKING TWO-DIMENSIONAL FREEZING FRONT MOVEMENT USING THE COMPLEX VARIABLE BOUNDARY ELEMENT METHOD,
Williamson and Schmid, Irvine, CA.
T. Hromadka.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A183 547. Price codes: A04 in paper copy, A01 in microfiche. Special Report 87-8, June 1987. 58p, 11 fig, 3 append.

Descriptors: *Frost, *Model studies, *Soil water, *Freezing, *Mathematical models, Computer models, Soil temperature, Heat, Mathematical studies.

The Complex Variable Boundary Element Method (CVBEM) is used to develop a computer model for estimating the location of the freezing front in soil water phase change problems. This computer program, CVBFR1, is based on the following major assumptions: (1) the problem is two-dimensional; (2) the entire soil system is homogeneous and isotropic; (3) the problem thermal boundary conditions are constant values of temperature (or stream function); (4) soil water flow effects are neglected (the problem is strictly geothermal); (5) all heat flow from the freezing front is within the control volume, there is not heat flux associated with the freezing front from exterior of the control volume; and (6) the freezing front movement is slow enough that heat flux along the moving boundary can be determined by assuming steady state heat flow conditions for small durations of time (i.e., timesteps). The CVBEN is used to model the thermal regime of the soil system. Because the numerical technique is a boundary integral approach, the control volume thermal regime is modeled with respect to the boundary values, and, therefore, the CVBFR1 data entry requirements are significantly less than those usually required of domain methods such as finite-differences or finite-elements. Soil water phase change along the freezing front is modeled as a simple balance between

computer heat flux and the evolution of soil water volumetric latent heat of fusion. To model the displacement of the freezing front, program CVBFR1 provides two options: (1) displace the freezing front coordinates with respect to changes in the y-coordinate only; or (2) displace the freezing front coordinates with respect to a vector normal to the freezing front boundary. (Author's abstract)
W89-02266

2H. Lakes

EFFECT OF NON-REMOVAL OF THE MACROPHYTIC BIOMASS ON THE CHARACTERISTICS OF WATER AND PLANT COMMUNITY IN LAKE NAINI TAL, U.P., INDIA,
Kumaun Univ., Naini Tal (India). Dept. of Botany.
R. Purohit, S. P. Singh, and N. Upreti.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 2, p 245-257, 1986. 6 fig, 4 tab, 34 ref.

Descriptors: *Lake Naini Tal, *India, *Littoral zone, *Macrophytes, *Aquatic productivity, Biomass, Thermal stratification, Hydrogen ion concentration, Dissolved oxygen, Calcium, Nitrogen, Nutrients, Species diversity, Seasonal variation, India, Lakes, Plant growth.

In the most productive macrophytes stand lying within the littoral zone of Lake Naini Tal (a Kumaun Himalayan Lake, 1937 m above sea level) the macrophytic biomass was removed at the time of peak biomass one year, but not during the next. The effect of non-removal of the macrophytes was apparent in the physical and chemical parameters of the water thermal stratification, pH, dissolved oxygen, calcium and nitrogen content. The removal of macrophytes increased the plant diversity. Seasonal patterns of ash, calcium and nitrogen content in plant tissues were different for the two years of study. (Author's abstract)
W89-01270

SEASONAL AND SPATIAL DISTRIBUTION OF IRON PRECIPITATING HETEROTROPHS IN WATER AND SEDIMENTS OF FISH PONDS OF DIFFERING FARMING MANAGEMENTS,
Kalyani Univ. (India). Dept. of Zoology.
B. B. Jana, and G. N. Patel.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 2, p 259-270, 1986. 3 fig, 3 tab, 19 ref.

Descriptors: *Iron bacteria, *Fish ponds, *Fish farming, Seasonal variation, Spatial distribution, Population density, Nitrites, Sediments, Aquaculture, Organic loading.

Population densities of primarily iron precipitating heterotrophs (metal-precipitating non-oxidizing bacteria) were estimated in water and sediments of ponds being used for polyculture, monoculture and traditional systems of fish farming over a period of 2.5 years. Spatial differences in microbial density in the ponds were related to the organic loading of the farm site and the type of farming. The highest bacterial populations occurred in November and the lowest in summer. Nitrite concentration was mainly responsible for such seasonal changes. (Author's abstract)
W89-01271

EFFECTS OF OIL REFINERY EFFLUENTS ON SELENASTRUM CAPRICORNUTUM PRINTZ,
Udai Pratap Coll., Varanasi (India).Dept. of Botany.
For primary bibliographic entry see Field 5C.
W89-01272

STRUCTURE OF PERIPHYTIC COMMUNITIES IN COOLING POND OF NUCLEAR POWER PLANT,
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
A. A. Protasov, and S. A. Afanasyev.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 3, p 335-347, 1986. 6 fig, 1 tab, 21 ref.

Descriptors: *Water pollution effects, *Aquatic habitats, *Cooling ponds, *Periphyton, Nuclear powerplants, Water temperature, Ukraine, Soviet Union, Temperature effects.

Periphyton (Dreissena, bryozoans, filamentous green algae, and green algae) was studied in the cooling pond of a nuclear power plant in the Ukraine. Fourteen periphytic communities were distinguished on the basis of an analysis of visually detected homogeneity distribution and with reference to results obtained from analysis of samples (species composition, abundance, and biomass). Relationships among communities were determined by E. S. Smirnov's method of pairwise comparison of character complexes (of communities). The periphytic communities were shown to be integrated in two large communities gravitating towards the thermogradient poles. Temperature was the important factor that determined the macrostructure of periphyton in the cooling pond. (Author's abstract)
W89-01273

ANTARCTIC STREAM ECOSYSTEMS: VARIABILITY IN ENVIRONMENTAL PROPERTIES AND ALGAL COMMUNITY STRUCTURE,
Department of Scientific and Industrial Research, Taupo (New Zealand). Taupo Research Lab.
C. Howard-Williams, C. L. Vincent, P. A. Broady, and W. F. Vincent.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 4, p 511-544, 1986. 18 fig, 11 tab, 43 ref.

Descriptors: *Antarctica, *Glacial streams, *Ecosystems, *Algae, Water temperature, Diel cycle, Air temperature, Solar radiation, Stream discharge, Nutrients, Sediments, Nitrogen, Phosphorus, Snowmelt, Seasonal variation, Algal growth, Biomass, Chlorophyll a, Species composition, Cyanophyta, Victoria Hand.

The variability in physical, chemical and biological properties was examined for a number of glacier melt streams in south Victoria Land, Antarctica. Streams flowed for between one and two months. Stream water temperatures (range 0-11 C) varied over short (hr) time scales while discharges varied considerably between streams (range 0.001-15 cu m/s) and over diel cycles. Solar radiation and air temperature were major determinants of stream discharge. Variability in discharge was reflected in variability in nutrient chemistry and sediment load. Nitrogen and phosphorus varied considerably between streams; the meltwaters early in summer contained 10-20 times higher levels of dissolved N and P than later in the season. Within stream nutrient levels were modified by dense algal growths and penguin rookeries. Epilithic algal communities were made up primarily of Cyanophyceae which formed mats and crusts. Longitudinal and horizontal variability of species in the communities in selected streams is described. Analyses of algal cover and biomass (chlorophyll a) show that substrate type and flow rates are of greater importance than nutrients in influencing algal abundance and biomass. In some streams biomass values of over 20 micrograms chlorophyll a/sq cm were recorded, much of which remains viable but inactive over the antarctic winter. (Author's abstract)
W89-01274

INTERRELATIONSHIPS AMONG THE EPIPELON, EPIPHYTON AND PHYTOPLANKTON IN A EUTROPHIC LAKE,
Alberta Univ., Edmonton. Dept. of Botany.
C. G. Jenkerson, and M. Hickman.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 4, p , 1986. 11 fig, 10 tab, 79 ref. Natural Sciences and Engineering Research Council of Canada Grant A6384.

Descriptors: *Lakes, *Eutrophic lakes, *Aquatic habitats, *Algae, *Limnology, *Epipelon, *Epiphyton, *Phytoplankton, Standing crops, Productivity, Nutrients, Population dynamics, Light, Temperature, Alkalinity, Hydrogen ion concentration, Bioindicators, Limnology.

Comparisons of the phytoplankton, epipelon, and eiphyton of a eutrophic prairie-parkland lake were conducted using simultaneous collection and similar processing. For all communities the 1% surface irradiance was at 1-2 meters due to shading algae, macrophytes, and wind mixed detritus, or due to ice and snow cover. Distributions of abiotic parameters were similar among communities. Temperatures in the epipelon were less rigorous than those in the phytoplankton, whereas temperatures in the epiphyton were more rigorous. For pH and phosphate, epiphyton>phytoplankton>epiphyton. Epipelie silica was highest. For species diversity, phytoplankton>epiphyton>epipelon. Vertical distributions were noted for species within each community. Dominant species from the phytoplankton and epiphyton were restricted within seasonal shock period boundaries, but dominants from the epipelon trespassed such environmental boundaries. There were 21 dominant species considered community indicators. Evidence suggested the epiphyton can be a collection site for senescing populations from all communities, but it also can act as an incubator site where sufficient light, heat, and nutrients initiate species growth that later is expressed in another community. Likewise the epipelon can be a disposal site for senescent populations, but it too can be a stable maintenance site where species from all communities survive, or even display active growth. Standing crop and productivity data showed similar spatial and temporal distributions for all communities. Interactions among the three communities were indicated as an orderly progression of first phytoplankton, then epipelon, and finally epiphyton peaks occurred within each season. The photosysnthetic index and efficiency were highest for the phytoplankton and the productivity efficiency was highest for the epiphyton. (Sand-PTT)
W89-01276

BACTERIAL ACTIVITY IN A RESERVOIR DETERMINED BY AUTORADIOGRAPHY AND ITS RELATIONSHIPS TO PHYTO- AND ZOOPLANKTON,
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
K. Simek.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 5, p , 1986. 4 fig, 5 tab, 60 ref.

Descriptors: *Limnology, *Bacteria, *Reservoirs, *Phytoplankton, *Zooplankton, Biomass, Bacterial physiology, Metabolism, Amino acids, Organic matter, Cladocerans, Lakes, Isotope studies, Rimoy Reservoir, Czechoslovakia, Autoradiography.

In the drinking water reservoir Rimov (Southern Bohemia) bacterioplankton was studied during 1983. Special attention was given to the relationships between parameters of bacterial abundance, total and individual activity. Bacterial counts and biomass were assessed and autoradiographic determinations of the proportions of active bacteria incorporating thymidine and mixture of amino acids and total uptake rate of amino acids were made over a year in the surface layer and during summer stratification from the thermocline and 15 m depth. Specific activity of metabolically active bacteria and specific activity per unit of biomass were negatively correlated with counts of metabolizing cells and with bacterial biomass, respectively. Total and individual heterotrophic activity and counts of bacteria coincided with the changes of phytoplankton biomass, whereas bacteria incorporating thymidine were more closely correlated with primary production. The most significant relation of metabolically active bacteria was found to cladoceran biomass. Thus, this part of heterotrophic bacterial activity seems to be stimulated by leakage of dissolved organic matter from phytoplankton being disrupted and incompletely digested by cladocerans rather than from healthy photosynthesizing cells. (Author's abstract)
W89-01277

ORGANIC CARBON FLUX TO A LARGE SALT LAKE: PYRAMID LAKE, NEVADA, USA,
Arizona State Univ., Tempe. Dept. of Zoology.
D. L. Galat.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 5, p 621-654, 1986. 19 fig, 11 tab, 85 ref. U.S. Bureau of Indian Affairs Contracts 14-15-0008-974 and 14-16-0009-82-1869.

Descriptors: *Limnology, *Pyramid Lake, *Nevada, *Lakes, *Saline lakes, *Energy, *Carbon cycle, *Organic carbon, *Primary productivity, *Macrophytes, Photosynthesis, Dusts, Fluvial transport, Photosynthesis, Drought, Diversion, Deserts.

Energy flux to a large, deep, salt lake from phytoplankton, periphyton and macrophyte primary production as well as fluvial transport and wind-transported terrestrial vegetation and dust were quantified. Average areal phytoplankton net photosynthesis was 511 mg C/sq m/d. Highest rates were during water-blooms of the blue-green alga, Nodularia spumigena. Although areal daily net photosynthesis by periphyton in Pyramid Lake was comparable to other salt lakes, annual carbon influx by periphyton was small due to the lake's graben morphology and moderate euphotic depth (mean, 11.9 m). The Truckee River is the only major fluvial discharge to Pyramid Lake and dissolved organic carbon was the principal organic carbon fraction in river water. Large upstream water diversions coupled with several drought years resulted in an average fluvial organic carbon load of only 7.3 g C/sq m/y or 4% of median phytoplankton net photosynthesis. Tumbleweeds were the most common terrestrial plant material observed in Pyramid Lake comprising a maximum projected importance of 6% of total annual carbon input. Windborne dust represented <.1% of annual carbon input. Phytoplankton primary production is the predominant energy source to Pyramid Lake, accounting for over 80% of annual carbon influx. The relative magnitude of autochthonous and allochthonous vectors to the annual carbon budget of this desert salt lake are comparable to those of the few other large lakes for which detailed energy input budgets have been calculated. (Author's abstract)
W89-01278

EFFECTS OF EXPERIMENTAL ACIDIFICATION ON PHYTO-, BACTERIO- AND ZOOPLANKTON IN ENCLOSURES OF A HIGHLY HUMIC LAKE,
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
For primary bibliographic entry see Field 5C.
W89-01279

STUDY OF BENTHIC COMMUNITIES IN SOME SALINE LAKES IN SASKATCHEWAN AND ALBERTA, CANADA,
Saskatchewan Univ., Saskatoon. Dept. of Biology.
B. V. Timms, U. T. Hammer, and J. W. Sheard.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 6, p 759-777, 1986. 4 fig, 7 tab, 41 ref. Grant A1412.

Descriptors: *Lakes, *Saline lakes, *Benthic fauna, *Macroinvertebrates, *Limnology, Midges, Amphipods, Aquatic insects, Species diversity, Biomass, Standing crops, Eutrophication, Saskatchewan, Alberta, Canada, Long-term studies.

The spring benthos of 22 lakes ranging from 1-88 g/l salinity contained 58 species of macroinvertebrates, but only 23 species occurred in waters >3 g/l. The amphipod Hyalella azteca and the chironomids Procladius freemani, Chironomus nr. muratensis and Cryptochironomus spp. were important at lower salinities (1-12 g/l) whereas the chironomids Tanypus nubifer, Cricotopus ornatus and Chironomus nr. annularis dominated at moderate salinities (5-30 g/l) and dolichopodid and ephyrid dipterans were the only species in hypersaline lakes (>50 g/l). Diversity decreased significantly with increased salinity. Mean dry biomass ranged from 0-9.12 g/sq m, showing little correlation with salinity, though hyposaline lakes often had elevated values and hypersaline lakes very low values. Shallow lakes (<5 m) had significantly lower standing crops. There were long term changes in biomass (over 45 years) in some lakes due to cultural eutrophication or secular changes in salinity. Chironomids were by far the dominant contributors to biomass at salinities to 50 g/l, above which dolichopodid and ephyrid dipterans dominated. The lakes were classified into four groups - subsaline, hyposaline, shallow hypo-mesosaline and hypersaline, reflecting the importance of salinity and also relative depth as major controlling factors. (Author's abstract) (Sand-PTT)
W89-01280

PHYTOPLANKTON BLOOM IN SHALLOW DIVOR RESERVOIR (PORTUGAL): THE IMPORTANCE OF INTERNAL NUTRIENT LOADING,
Instituto Nacional de Investigacao des Pescas, Lisbon (Portugal).
For primary bibliographic entry see Field 5C.
W89-01282

ALGAE FLOCCULATION IN RESERVOIR WATER,
Southern Petrochemical Industries Corp. Ltd., Tuticorin (India).
For primary bibliographic entry see Field 5G.
W89-01285

MULTITABLE ANALYSES IN FACTORIAL ECOLOGY: II. LONGITUDINAL STRATIFICATION OF THE ARDECHE, BEGINNING WITH PHYSICO-CHEMICAL DESCRIPTORS (LES ANALYSES MULTITABLEAUX EN ECOLOGIE FACTORIELLE: II. STRATIFICATION LONGITUDINALE DE L'ARDECHE A PARTIR DE DESCRIPTEURS PHYSICO-CHEMIQUES),
Lyon-1 Univ., Villeurbanne (France).
S. Doledec.
Acta Oecologia, Oecologia Generalum AOSGD7, Vol. 9, No. 2, p 119-135, 1988. 6 fig, 4 tab, 64 ref. English summary.

Descriptors: *Path of pollutants, *Water pollution sources, *Ardeche River, *France, *Rivers, Lotic environment, Water pollution, Wastewater disposal, Triadic analysis, Ionic compounds, Organic compounds, France, Water pollution effects, Principal component analysis, Geohydrology.

A typology of the Ardeche waters (France) was undertaken during the summer period along approximately 100 km of its course taking into account 9 physical and chemical properties. Four functional sectors were distinguished using a multitable analysis known as Triadic Analysis. This analysis incorporates 3 steps: (1) the data are centered (elimination of the mean) and reduced (division by standard deviation) by sampling date and by variable. The data table is then reorganized to have sampling dates as columns and all the variables for each station as lines. This table is processed with a principal component analysis (PCA, centered) and thus defines the interstructure, which is an overall description of the sampling dates (typology by variable); (2) compromise tables (models), which are associated with the successive PCA factors of the interstructure, are produced. In this study, only the first compromise table is considered; this table is a summary as close as possible to the situation at each of the sampling dates. The analysis (centered PCA) of this compromise table enabled the simultaneous representation of the stations (dates) and of the variables that define the typology; and (3) the intrastructure (projection of supplementary individuals, which are the lines from the recognized table from step 1 in the PCA compromise process) enabled the representation of each station at each date, and of each variable at each date. This representation is thus a detailed analysis of the temporal succession of the typology by station or by variable. The typology produced here from analysis of the first compromise table was influenced by geological conditions, pollution inputs and by an increase of ionic compounds along the river course.
W89-01293

DISTRIBUTION AND ANNUAL DYNAMICS OF THE BENTHIC MACROFAUNA OF LAKE LEMAN (PETIT-LAC) AS A FUNCTION OF DEPTH: PRELIMINARY RESULTS (REPARTITION ET DYNAMIQUE ANNUELLE DE LA MACROFAUNE BENTHIQUE EN FONCTION DE LA PROFONDEUR DANS LE LEMAN (PETIT-LAC): RESULTATS PRELIMINAIRES),
Geneva Univ. (Switzerland). Unite de Biologie Aquatique.
B. Lods-Crozet, B. Bauer, R. Juge, D. Pattay, and J. Perfetta.
Archives des Sciences, Geneve ASGVAH, Vol. 38, No. 1, p 23-25, January-April 1985. 4 fig, 1 tab, 32 ref. English summary.

Descriptors: *Limnology, *Lakes, *Benthic fauna, *Invertebrates, Mollusks, Oligochaetes, Crustaceans, Insects, Aquatic insects, Midges, Tricladida, Hirudinia, Species composition, Population density, Petit-Lac.

The study of the Lake Geneva (Petit-Lac) benthic fauna was undertaken in 1977-78 at depths of 0 to 30 m. The macrofauna comprises 48 taxa that mainly belong to the following groups: Tricladida, Mollusca, Oligochaeta, Hirudinea, Crustacea and Insecta. The density of these organisms is higher in the sampling areas of the north shore then in those of the south shore. The benthos community is quantitatively dominated by the Oligochaeta and Chironomidae larvae and the Oligochaeta/Chironomidae ratio tends to increase with depth. (Author's abstract)
W89-01313

CONFLICTS BETWEEN WETLAND CONSERVATION AND GROUNDWATER EXPLOITATION: TWO CASE HISTORIES IN SPAIN,
Universidad Complutense de Madrid (Spain). Dept. of Geodynamics.
M. R. Llamas.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 3, p 241-251, June 1988. 9 fig, 16 ref.

Descriptors: *Irrigation, *Environmental impact, *Wetlands, *Marshes, *Groundwater, *Aquifers, *Conservation, National parks, Spain, Discharge, Recharge, Irrigation, Water table depletion.

The problems in two Spanish national parks located on wetlands are analyzed. The hydrogeological and ecological characteristics of the parks are somewhat different as are their respective degrees of deterioration. The Tablas de Daimiel National Park is located on the Central Plateau of Spain. It used to consist of a marshy area of about 20 sq km around the confluence of two relatively small rivers. The area was marshy mainly because it was the natural discharge zone for a Tertiary aquifer system about 100 m thick extending over an area of 5000 sq km, composed of calcareous and detrital material of continental origin. The average annual recharge has been estimated at approximately 350 h x cu m/yr. Current groundwater withdrawal is around 450 h x cu m/yr, mainly used to irrigate a surface area of some 1000 sq km. This overdevelopment has led to a continuous depletion of the regional water table and eventually to the drying out of the marshy area. Spontaneous combustion or fires caused by man has occurred in about 10 sq km of the desiccated areas since the spring of 1986. The Donana National Park is located on the estuary of the River Guadalquivir. The aquifer system of this estuary consists essentially of a permeable formation of unconsolidated Plioquaternary materials with an area of 3000 sq km. Under the marshy area the aquifer system is confined below low-permeability estuary deposits which can be over 100 m thick. Around most of the marshland the aquifer crops out and is recharged by rain. The Donana National Park is over 700 sq km, part of which is in the marshland and part in the recharge area where the aquifer is phreatic. In the 1970's Spain's largest irrigation project using groundwater, covering a surface area of 240 sq km, was planned in area bordering on the national park. The initial project was scaled down considerably as a result of protests by conservation groups. However, it seems likely that the water table de-

pletion as a result of pumpage for irrigation could cause a large part of the ecotone situated at the contact-line between the marshland and the phreatic aquifer to disappear. This ecotone exists because it is a natural groundwater discharge area. (Author's abstract)
W89-01319

HYDROLOGIC INFLUENCES ON LEAF DECOMPOSITION IN A CHANNEL AND ADJACENT BANK OF A GALLERY FOREST STREAM,
Kansas State Univ., Manhattan. Dept. of Systematics and Ecology.
M. E. Gurtz, and C. M. Tate.
American Midland Naturalist AMNAAF, Vol. 120, No. 1, p 11-21, July 1988. 4 fig, 3 tab, 17 ref. Kansas Water Resources Research Institute, Project No. B-063-KAN and National Science Foundation Grant BSR 8012166.

Descriptors: *Floods, *Flood plains, *Leaves, *Decomposition, *Forest hydrology, Riparian vegetation, Kings Creek, Kansas, Streams, Forests, Prairies.

Hydrologic extremes of flooding and drought typically occur each year in prairie streams. Two experiments were conducted in a fifth-order, gallery forest reach of Kings Creek, Kansas, to assess the effect of hydrologic conditions on decomposition of leaves in the stream channel and on the adjacent floodplain. Temporal patterns of weight loss were examined in the first experiment. Leaves of bur oak and hackberry decomposed more rapidly in the channel than on the adjacent bank. A sharp drop in percent remaining for hackberry in the 2nd month (mid-December to mid-January) coincided with a period of high shredder densities on hackberry leaves. On the bank, decomposition of hackberry leaves was fastest during intervals that included one or more inundations of the leaf packs. Bur oak leaves decomposed more slowly than hackberry leaves and were influenced less by the hydrologic history. In the second experiment, spatial variation in decomposition rate of hackberry leaves was examined by placing 20 pairs of leaf packs in a transect extending from the center of the stream channel to the top of the upper bank. Position on the transect affected the frequency and duration of inundations on the floodplain, which ranged from once to 17 times, while 3 pairs of packs in the channel were always under water. The logarithm of percent remaining after 274 days was significantly correlated with number of hours inundated and number of times inundated, although other factors such as soil moisture or amount of flood-deposited silt may have influenced differences in decomposition rates along the transect. It is concluded that flood frequency, duration and timing affect both spatial and temporal patterns of decomposition, especially of a fast-decomposing species, in the riparian forest of an intermittent prairie stream. (Author's abstract)
W89-01331

USE OF PLASTIC STRIPS TO MEASURE LEAF RETENTION BY RIPARIAN VEGETATION IN A COASTAL OREGON STREAM,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 7B.
W89-01332

MICROHABITAT USE BY THE BIGMOUTH CHUB NOCOMIS PLATYRHYNCHUS IN THE NEW RIVER, WEST VIRGINIA,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
M. D. Lobb, and D. J. Orth.
American Midland Naturalist AMNAAF, Vol. 120, No. 1, p 32-40, July 1988. 2 tab, 20 ref.

Descriptors: *Fish, *Aquatic habitats, *Spawning, Chubs, Flow velocity, New River, West Virginia.

Habitat preferences of spawning and nonspawning N. platyrhynchus were quantified in the New River, West Virginia. Habitat variables were measured at nesting areas during spring; underwater observations determined macro- and microhabitat use during late summer. N. platyrhynchus used areas with an abundance of small to large gravel (3-64 mm diameter), shallow depths (0.15-0.75 m) and moderate velocities (0.05-0.69 m/s) for constructing spawning mounds. During late summer, N. platyrhynchus stayed near the substrate, where velocities were significantly lower than mean column velocities. Proposed daily flow fluctuations for power production could affect spawning success and these findings can be used to determine appropriate limits of daily flow fluctuations. (Author's abstract)
W89-01333

OPALINE CHERTS ASSOCIATED WITH SUBLACUSTRINE HYDROTHERMAL SPRINGS AT LAKE BOGORIA, KENYA RIFT VALLEY,
Saskatchewan Univ., Saskatoon. Dept. of Geological Sciences.
R. W. Renaut, and R. B. Owen.
Geology GLGYB, Vol. 16, No. 8, p 699-702, August 1988. 3 fig, 1 tab, 26 ref.

Descriptors: *Chert, *Hot springs, *Saline lakes, Diatoms, Silica, Hydrogen ion concentration, Lithification, Lake Bogoria, Kenya.

An unusual group of cherts found at saline, alkaline Lake Bogoria in the Kenya Rift differs from the Magadi-type cherts commonly associated with saline, alkaline lakes. The cherts are opaline, rich in diatoms, and formed from a siliceous, probably gelatinous, precursor that precipitated around submerged alkaline hot springs during a Holocene phase of high lake level. Silica precipitation resulted from rapid drop in the temperature of the spring waters and, possibly, pH. Lithification began before subaerial exposure. Ancient analogous cherts are likely to be localized deposits along fault lines. (Author's abstract)
W89-01334

FOG EFFECT OF THE GREAT SALT LAKE,
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 2B.
W89-01376

FACTORS CONTROLLING THE SECONDARY PRODUCTIVITY OF BENTHIC MACROINVERTEBRATES IN FRESHWATERS: A REVIEW, (IN JAPANESE),
National Inst. for Environmental Studies, Ibaraki (Japan). Environmental Biology Div.
T. Iwakuma.
Japanese Journal of Ecology JJECDN, Vol. 36, No. 3, p 169-187, 1986. 3 fig, 5 tab, 135 ref. English summary.

Descriptors: *Benthic fauna, *Secondary productivity, *Macroinvertebrates, *Aquatic productivity, Midges, Ecosystems, Biomass, Aquatic populations, Lotic environment, Lentic environment, Aquatic insects, Insect emergence, Cycling nutrients.

Among the groups of secondary producers, Chironomidae were the most productive, both in standing and running waters. A regression analysis was performed on the reported secondary production (P) data for 39 herbivorous and detritivorous chironomid species in 37 standing waters. Annual mean biomass (B sub a) was positively related to the maximum body weight of fourth-instar larvae (w sub 4max); the P/B ratio was positively related to annual mean bottom temperature and inversely related to w sub 4max. Production decreased with increasing mean water depth (z sub mean). The latter relationship was also true for herbivorous and detritivorous zoobenthos. Secondary production of herbivores and detritivores including zooplankton and zoobenthos was ca. 10% of primary production in lakes. Zoobenthos production became comparable to that of zooplankton in lakes where primary production exceeded ca. 10,000 kg/sq m/y. Emerging biomass (E) of chironomids amounted to 0.1-1.16% of the sum of primary production and allochthonous organic matter. E/P values lay within 0.2-0.5 and tended to decrease with increasing P. Collection of emerging insects is recommended as a valid means of estimating species production. Annual chironomid production may be estimated by multiplying species annual emerging biomass by a factor of 2.8. The role of secondary producers in an ecosystem's nutrient cycling is discussed. (Author's abstract)
W89-01382

CHANGES IN FOOD (CHLORELLA) LEVELS AND THE ACUTE TOXICITY OF CADMIUM TO DAPHNIA CARINATA (DAPHNIDAE) AND ECHINISCA TRISERIALIS (MARCOTHRICIDAE) (CRUSTACEA: CLADOCERA),
Delhi Univ. (India). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W89-01397

RECHARGE-DISCHARGE FUNCTION OF WETLANDS NEAR JUNEAU, ALASKA: PART II. GEOCHEMICAL INVESTIGATIONS,
Syracuse Univ., NY. Dept. of Geology.
For primary bibliographic entry see Field 2A.
W89-01403

SHEAR WAVES AND UNSTEADY SELECTIVE WITHDRAWAL,
Stanford Univ., CA. Dept. of Civil Engineering.
S. Monismith, J. Imberger, and G. Billi.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 114, No. 9, p 1134- 1152, September 1988. 9 fig, 2 tab, 16 ref, 3 append.

Descriptors: *Selective withdrawal, *Unsteady flow, *Shear, *Waves, *Shear waves, *Internal waves, *Reservoirs, *Stratification, Flow, Wave propagation, Boundary conditions.

An experimental study examining the generation of internal waves by unsteady inertial outflows from a stratified reservoir is presented. The experiments show that shear waves generated when the outflow is begun are identical to those generated when the outflow is stopped. The amplitudes of the lowest mode shear waves can be calculated by assuming that they combine to form the steady withdrawal-layer velocity profile at the wall. As R, the parameter governing steady withdrawal behavior, is increased, the observed shear-wave amplitudes decrease relative to their theoretical values, with the discrepancy increasing with increasing mode number. When the outflow is repeatedly pulsed, the strength of the average flow towards the sink indicates the existence of a withdrawal layer thicker than that which would have been formed given either the average flow rate or the maximum instantaneous flow rate. This observation suggests that one effect of unsteady withdrawals may be to create thicker withdrawal layers than are found for similar steady withdrawals. (Author's abstract)
W89-01420

DETERMINATION OF FORMATE IN NATURAL WATERS BY A COUPLED ENZYMATIC/HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC TECHNIQUE,
Rosenstiel School of Marine and Atmospheric Science, Miami, FL. Div. of Marine and Atmospheric Science.
D. J. Kieber, G. M. Vaughan, and K. Mopper.
Analytical Chemistry ANCHAM, Vol. 60, No. 17, p 1654-1659, September 17 1988. 6 fig, 1 tab, 18 ref.

Descriptors: *Water analysis, *Pore water, *Seawater, *Chromatography, *Enzymes, *Formic acid, Rain, Fatty cells, Dehydrogenase, High performance liquid chromatography, Sediments.

An enzymatic method was developed to quantify formic acid in natural water samples at submicromolar concentrations. The method is based on the oxidation of formate by formate dehydrogenase with corresponding reduction of beta-nicotinamide adenine dinucleotide reduced (beta-NAD+) to beta-nicotinamide adenine dinucleotide (beta-NADH); beta-NADH is quantified by reversed-phase high-performance liquid chromatography with fluorometric detection. An important feature

of this method is that the enzymatic reaction occurs directly in aqueous media, even seawater, and does not require sample pretreatment other than sample filtration. The reaction proceeds at room temperature at a slightly alkaline pH (7.5-8.5) and is specific for formate with a detection limit of 0.5 microMolar concentration for a 200 microliter injection. The precision of the method was 4.6% relative standard deviation for a 0.6 microMolar concentration standard addition of formate to Sargasso seawater. Average recoveries of 2 microMolar concentration additions of formate to seawater, pore water, or rain were 103, 103, and 87%, respectively. Intercalibration with a Dionex ion chromatographic system showed an excellent agreement of 98%. Concentrations of formate present in natural samples ranged from 0.2 to 0.8 microMolar concentration for Biscayne Bay seawater, 0.4 to 10.0 microMolar concentration for Miami rain, and 0.9 to 8.4 microMolar concentration for Biscayne Bay sediment pore water. (Author's abstract)
W89-01421

SEDIMENT-WATER OXYGEN AND NUTRIENT FLUXES IN A RIVER-DOMINATED ESTUARY,
Louisiana State Univ., Baton Rouge. Coastal Ecology Lab.
For primary bibliographic entry see Field 2L.
W89-01422

ESTIMATING THE NET FLUX OF NUTRIENTS BETWEEN A SALT MARSH AND A TIDAL CREEK,
South Carolina Univ., Columbia. Dept. of Statistics.
For primary bibliographic entry see Field 2L.
W89-01423

EFFECT OF SUSPENDED SEDIMENT ON THE HEATING OF LAKE BANYOLES,
Los Angeles County Natural History Museum Foundation, CA.
X. Casamitjana, and E. Roget.
Journal of Geophysical Research (C) JGRCEY, Vol. 93, No. 8, p 9332-9336, August 15, 1988. 5 fig, 2 tab, 14 ref.

Descriptors: *Lake Banyoles, *Heated water, *Spain, *Thermal springs, *Sediments, *Mathematical models, Suspended sediments, Hypolimnion, Advection, Turbulent flow, Water temperature, Seasonal variation, Lakes, Groundwater.

Lake Banyoles, of karstic origin, is continually heated by the incoming groundwater. This water enters the lake at certain places which are basin-shaped, keeping sediment in suspension. The temperature of suspended sediment is 2-3 C higher than of hypolimnetic water in summer, and 8-10 C higher in winter. Because of this the cooling of the Lake is measurably lessened. A model to calculate the heat flux from advective heat fluxes was considered. The degree of turbulence of the water at the interface of suspended sediment was also evaluated. The model was applied over a 1 yr cycle. In Lake Banyoles the temperature of the sediment is almost constant, and the heat flux is always from the suspended sediment to the lake. In February this flux is the highest because the gradients are higher; in this month the total number of joules entering the lake per square meter of surface area is 78,922,000, and in September it has decreased to 11,297,700. If the lake were not heated from below the heat budget would increase by J/square m, which is the difference between the last two quantities. The contribution to the underground heating from hard sediments was not considered. This omission may be made because the natural heat flow is several orders of magnitude lower than the heat flux from underground fluid discharge. The evaluation of the thermal diffusivity at the interface is necessary because of the importance of the diffusive flux. The degree of turbulence at the interface is not very strong compared with turbulence in many hypolimnetic waters, where thermal diffusivities can be 1000 times the molecular one. (Hammond-PTT)
W89-01435

EFFECT OF PROLONGED EXPOSURE TO ACETYLENE ON DENITRIFICATION IN A LABORATORY STREAM SEDIMENT SYSTEM,
Oxford Univ. (England). Dept. of Plant Sciences.
For primary bibliographic entry see Field 7B.
W89-01446

IN-STREAM NITRIFICATION RATE PREDICTION,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-01450

LAKE AND RESERVOIR MANAGEMENT,
Environmental Protection Agency, Dallas, TX. Region VI.
For primary bibliographic entry see Field 5G.
W89-01497

EFFECTS OF POLLUTION ON FRESHWATER ORGANISMS,
American Scientific International, Duluth, MN.
For primary bibliographic entry see Field 5C.
W89-01502

EFFECT OF OXYGEN ON THE GROWTH OF YOUNG AYU, (IN JAPANESE),
Tokyo Univ. (Japan).
K. Chiba.
Nippon Suisan Gakkaishi NSUGAF, Vol. 54, No. 2, p , February 1988. 4 fig, 2 tab, 16 ref. English summary.

Descriptors: *Ayu, *Fish farming, *Oxygen, *Metabolism, Temperature effects, Dissolved oxygen, Fish.

Experiments were carried out to examine the effect of dissolved oxygen on the growth of young ayu (body weight 2.0-8.0 g). Fish were reared for 8 days in 5 different tanks. Each of these tanks had a volume of 16 l. These tanks were continuously supplied with fresh water having different dissolved oxygen concentrations. Reduced oxygen concentrations were maintained by bubbling nitrogen gas through the inflowing water. During the experiments water temperature ranged between 24 C and 25 C. Fish were fed three times a day with commercially available, crumbled pellet for young ayu. Fish showed almost even levels of growth rate and feed conversion efficiency in water of 45% or more in percent oxygen saturation, while below 45% these levels decreased with the reduction of oxygen concentration. Growth rates and feed conversion efficiencies at the oxygen concentrations of 27% and 35% in percent oxygen saturation were about 1/2 and 1/2-2/3 of those at over 45%, respectively. However, the feeding rate reduced with the decrease in dissolved oxygen within the whole range of the oxygen examined. (Author's abstract)
W89-01509

EFFECT OF SALINITY AND TEMPERATURE GRADIENTS ON THE DISTRIBUTION OF LITTORAL MICROALGAE IN EXPERIMENTAL SOLAR PONDS, DEAD SEA AREA, ISRAEL,
Hebrew Univ. of Jerusalem (Israel). Human Environment Sciences Div.
I. Dor, and A. Ehrlich.
PSZNI: Marine Ecology, Vol. 8, No. 3, p 193-205, 1987. 5 fig, 2 tab, 28 ref.

Descriptors: *Cyanophyta, *Diatoms, *Dead Sea, *Littoral zone, *Solar ponds, *Algae, Salinity, Temperature effects, Microorganisms, Bacteria, Ponds, Seasonal variation.

Several species of cyanobacteria, diatoms and one euglenoid alga populated the littoral zone of hypersaline solar ponds investigated over a period of three years. The composition of the microalgae community changed with salinity and temperature. In the shallow marginal zone the diatoms predominated in winter and spring, a salinities of 30-72 g per l and at temperatures not exceeding 30 C, whereas in summer, cyanobacteria were the most abundant. In the deeper zone, at higher salinities and temperatures, cyanobacteria predominated throughout the year. The depth limit of algal growth was 60-80 cm, where salinity and temperature exceeded 211 g/l and 48 C, respectively. (Author's abstract)
W89-01521

STRUCTURE OF THE EPIPHYTIC COMMUNITY OF POSIDONIA OCEANICA LEAVES IN A SHALLOW MEADOW,
Stazione Zoologica di Napoli (Italy).
For primary bibliographic entry see Field 2L.
W89-01522

PRIVATE RIGHTS AND THE PUBLIC TRUST: OPPOSING LAKESHORE FUNNEL DEVELOPMENT,
For primary bibliographic entry see Field 6E.
W89-01529

RATIONALE FOR SAMPLING AND INTERPRETATION OF ECOLOGICAL DATA IN THE ASSESSMENT OF FRESHWATER ECOSYSTEMS.
For primary bibliographic entry see Field 7B.
W89-01599

RATIONALE FOR DATA COLLECTION AND INTERPRETATION IN THE NORTHERN LAKES LONG-TERM ECOLOGICAL RESEARCH PROGRAM,
Wisconsin Univ.-Madison. Center for Limnology.
For primary bibliographic entry see Field 7A.
W89-01601

SAMPLING EFFORT REQUIRED TO FIND RARE SPECIES OF FRESHWATER MUSSELS,
Michigan Univ.-Dearborn.
For primary bibliographic entry see Field 7A.
W89-01602

RATIONALE AND SAMPLING DESIGNS FOR FRESHWATER MUSSELS UNIONIDAE IN STREAMS, LARGE RIVERS, IMPOUNDMENTS, AND LAKES,
Tennessee Valley Authority, Muscle Shoals, AL. Div. of Air and Water Resources.
For primary bibliographic entry see Field 7A.
W89-01603

USE OF DETRENDED CORRESPONDENCE ANALYSIS IN EVALUATING FACTORS CONTROLLING SPECIES COMPOSITION OF PERIPHYTON,
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-01607

SAMPLING AND INTERPRETATION OF ALGAL PATTERNS FOR WATER QUALITY ASSESSMENTS,
Louisville Univ., KY. Dept. of Biology.
For primary bibliographic entry see Field 7C.
W89-01608

LEAF PROCESSING IN A RESERVOIR: AN EXPERIMENTAL APPROACH,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 7A.
W89-01609

ROLE OF AQUATIC MACROPHYTES IN NUTRIENT FLOW REGULATION IN LOTIC ECOSYSTEMS,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
For primary bibliographic entry see Field 5B.

W89-01610

DEVELOPING A SAMPLING STRATEGY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
For primary bibliographic entry see Field 7A.
W89-01611

AQUATIC INVERTEBRATE RESEARCH,
Georgia Univ., Athens. Dept. of Entomology.
J. B. Wallace.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 257-268, 3 tab.

Descriptors: *Invertebrates, *Aquatic environment, *Coweeta, *North Carolina, *Forest ecology, *Particulate matter, *Detritus, *Insects, Ecosystems, Research priorities, Pesticides, Chironomids, Ecological effects, Biomass, Productivity, Organic matter.

Most aquatic research at Coweeta has focused on the effect of watershed disturbance on stream biota and stream ecosystem function. These studies have involved changes in energy inputs to streams including alteration of the surrounding forest and changes in physical characteristics of streams such as increased sediment loads during and after catchment disturbance. Benthic invertebrates are small and represent an insignificant portion of total catchment biomass; therefore, the suggestion that they influence ecosystem function would seem remote at first glance. The suggestion that insect shredders can generate considerable quantities of fine particulate organic matter (FPOM) and dissolved organic carbon (DOC) by their feeding is supported by indirect evidence such as high ingestion rates, low assimilation efficiencies, and their ability to comminute coarse particulate organic matter (CPOM) to FPOM. An experiment was devised to examine the role of insects in processing CPOM in two small headwater streams at Coweeta. A pesticide was applied to one of two adjacent streams, which resulted in massive invertebrate drift (primarily aquatic insects) from the treated stream. Leaf species breakdown rates were studied concurrently with the pesticide treatment and exhibited the same relative sequence of breakdown in both the treated and the reference stream (i.e., dogwood > red maple > white oak > rhododendron). These studies indicated that benthic invertebrates play an active and substantial role in the processing of CPOM to FPOM in headwater streams. Undisturbed Coweeta streams tend to retain a large portion of their CPOM inputs. The biota, dominated by shredder biomass, exploit these retentive characteristics by feeding on the retained CPOM and in doing so comminute CPOM to FPOM, which is more easily entrained and transported downstream. Conversely, in larger downstream reaches which are less easily subjected to channel obstruction, the physical characteristics favor entrainment. Entrainment and physical transport probably overwhelm the retention capacity of the biota. Annual estimates of P/B (production/X(=mean)biomass) ratios of chironomids range from < 1 in arctic tundra ponds to more than several hundred in warm streams. Annual P/B's for chironomids may approach 20 to 50 at Coweeta. Based on a pretreatment chironomid biomass of 86 mg ash feed dry mass (AFDM)/sq m for the pesticide treated stream and a daily growth rate of ca 0.125 mg mg AFDM body wt/d, chironomid production alone may approach 4 gm AFDM sq m/yr. (See also W89-01691) (Lantz-PTT)
W89-01703

TROPHIC SIGNIFICANCE OF DISSOLVED ORGANIC CARBON IN STREAMS,
Georgia Univ., Athens. Dept. of Botany.
For primary bibliographic entry see Field 2E.
W89-01704

ACCELERATING RECOVERY OF THE MERCURY-CONTAMINATED WABIGOON/ENGLISH RIVER SYSTEM.
Ontario Ministry of the Environment, Thunder Bay (Ontario).
For primary bibliographic entry see Field 5G.
W89-01730

REGULATED STREAMS: ADVANCES IN ECOLOGY.
Plenum Press, New York, 1987. 431p. Edited by John F. Craig and J. Bryan Kemper.

Descriptors: *Ecology, *Symposia, *Regulated flow, *Streams, Fish, Invertebrates, Water quality, Case studies, Model studies.

The contributions and attendance at the Third International Symposium on Regulated Streams held at Edmonton, Alberta, in August, 1985, was a strong indication of the continuing interest in regulated stream ecology. The keyword to the symposium was 'advances' both in basic science and scientific management of regulated streams. The papers are grouped under the headings Fish Ecology, Invertebrate Ecology, Physical Processes, Water Quality and Special Topics, although there is much overlap between sections. As far as possible, the editorial approach has been to present first articles which give an overview of the subject for that group and many of these contributions discuss the development of models. The papers outline empirical data that have been collected, often in support of these models. Finally, contributions describing case histories are given. In the summary the editors attempted to synthesize the main contributions and make some conclusions especially pertaining to the direction of future research. (See W89-01736 thru W89-01764) (Lantz-PTT)
W89-01736

SIMULATING TROUT FEEDING STATIONS IN INSTREAM FLOW MODELS,
Washington State Dept. of Game, Olympia.
H. A. Beecher.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 71-82, 6 fig, 2 tab, 20 ref.

Descriptors: *Trout, *Simulation analysis, *Instream flow, *Model studies, *Stream biota, *Feeding rates, Flow velocity, Ecological effects, Mathematical studies.

Hydraulic simulation has several variations, but each predicts depth and velocity distributions over an array of discrete, contiguous units of streambed area ('cells') at a series of specified stream discharges. Substrate or cover values are assigned to each cell. The habitat function, HABTAT, uses substrate or cover together with depth and velocity at a specified discharge to calculate a relative habitat value for each cell. Relative habitat value multiplied by surface area of the cell is summed for all cells to yield a weighted usable area (WUA) for each specified discharge. HABTAT uses functions called habitat preference curves or suitability of use criteria to calculate relative habitat value given depths, velocity, and substrate or cover. Habitat preference curves assign weighting or a preference factor ranging from 0 to 1 to each habitat value. A preference factor of 0 for velocity V sub z implies that adult rainbow trout do not inhabit water with velocity V sub z. A preference factor of 1 for velocity V sub y implies that the adult rainbow trout inhabit water with velocity V sub y as much as or more than any other velocity, all else being equal. WUA can be very sensitive to habitat preference curves. (See also W89-01736) (Lantz-PTT)
W89-01741

EFFECTS OF VARYING FLOWS IN MAN-MADE STREAMS ON RAINBOW TROUT (SALMO GAIRDNERI RICHARDSON) FRY,
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
J. R. Irvine.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 83-97, 10 fig, 1 tab, 19 ref.

Descriptors: *Stream biota, *Flow regulation, *Trout, *Streamflow, *Streams, *Ecological effects, Fish migration, Flow velocity.

The construction in 1980 of the lower Waitaki River replicate stream channels in New Zealand allowed the possibility of studying regulated stream flow with controls in space and time. The purpose of this paper is to present results from two experiments in which the effects of flow changes, simulating conditions below a hydroelectric peaking plant, on rainbow trout fry emigration, growth and condition, production and habitat preferences were examined. Up to five-fold flow changes occurring twice daily, five days per week, had remarkably little effect on rainbow trout fry, illustrating how well-adapted fry are to varying discharge. Downstream emigration was not affected. However, in separate experiments at the replicate streams, downstream emigration of chinook or quinnat salmon fry was increased by fluctuating discharge. Varying flows resulted in significant weight gain for rainbow trout in the low density stream. Invertebrate drift densities sometimes increased during flow changes. Trout habitat preferences were similar in constant flowing and fluctuating streams. (See also W89-01736) (Lantz-PTT)
W89-01742

DEVELOPMENT AND APPLICATIONS OF MACROINVERTEBRATE INSTREAM FLOW MODELS FOR REGULATED FLOW MANAGEMENT,
Tulsa Univ., OK. Faculty of Biological Science.
For primary bibliographic entry see Field 4A.
W89-01743

STONEFLIES AND RIVER REGULATION - A REVIEW,
Oslo Univ. (Norway). Zoological Museum.
S. J. Saltveit, J. E. Brittain, and A. Lillehammer.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 117-129, 72 ref.

Descriptors: *Stoneflies, *River regulations, *Ecological effects, *Stream biota, *Flow regulation, *Regulated flow, *Literature review, Insects, Streamflow, Water temperature, Oxygen, Distribution patterns, Flow profiles.

Stoneflies (Plecoptera) are a widespread and abundant order of benthic freshwater insects, especially in the running waters of temperate regions. They occupy a central role in trophic relationships both in terms of functional feeding groups and as fish food organisms. Current is a major factor controlling the distribution and abundance of most lotic organisms and this is also the case for stoneflies. River regulation invariably modifies both flow patterns and discharge. This can lead not only to changes in current speed and substrate, but also to changes in water temperature, oxygen content, drift and trophic structure. Temperature is another major factor controlling the distribution, abundance and life cycles of aquatic insects and several of the studies on the effect of river regulation on stoneflies have cited temperature as a major environmental factor. In this review, the known effects of river regulation on stoneflies, and hypotheses to explain its differing effect, both under varying regulation schemes and in various regions of the world, are summarized. (See also W89-01736) (Lantz-PTT)
W89-01744

THERMAL 'RESETTING' OF STREAMS BY RESERVOIR RELEASES WITH SPECIAL REFERENCE TO EFFECTS ON SALMONID FISHES,
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 6G.
W89-01747

NATURAL SILTATION OF BROWN TROUT (SALMO TRUTTA L.) SPAWNING GRAVELS DURING LOW-FLOW CONDITIONS,
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 2J.
W89-01751

STUDY DESIGN FOR FISHERIES AND HYDROLOGY ASSESSMENT IN A GLACIAL WATERSHED IN BRITISH COLUMBIA,

British Columbia Hydro and Power Authority, Vancouver.

H. A. Smith, S. P. Blachut, and B. Bengeyfield.

IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 289-301, 5 fig, 4 tab, 14 ref.

Descriptors: *Fisheries, *Hydrologic studies, *Rivers, *Stream biota, British Columbia, Glacial watersheds, Canada, Glacial streams, Fish, Ecosystems.

In Canada those rivers with glaciated catchments and salmonids primarily include major rivers which transect the Coast Mountains, of which the Homathko River is an example. These river basins are characterized by very rugged topography, steep gradients, high precipitation and heavy glaciation. The rivers are utilized by significant runs of wild stocks of anadromous and resident salmonids. This combination of important fisheries stocks utilizing complex mountainous glacial rivers in remote locations presents numerous problems beyond a typical instream flow assessment, including a study design, logistics and lack of historical data. These glacial river systems present a very dynamic physical environment. As a result, the fish populations are adapted to such variability. Study methodologies require considerable assessment and modification to the specific river under investigation. 'Off-the-shelf' models will not necessarily address all the significant parameters identified by hydrology-fisheries linkage studies. The importance of understanding the habitat-population linkages must not be underestimated, as the ultimate result of an impact assessment should be in terms of number of fish, area of habitat. (See also W89-01736) (Lantz-PTT)
W89-01756

PHOSPHORUS SPIRALLING IN RIVERS AND RIVER-RESERVOIR SYSTEMS: IMPLICATIONS OF A MODEL,

Academy of Natural Sciences of Philadelphia, Avondale, PA. Stroud Water Research Center.

J. D. Newbold.

IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 303-327, 8 fig, 2 tab, 98 ref.

Descriptors: *Phosphorus, *Rivers, *Model studies, *Reservoirs, *Ecological effects, *Cycling nutrients, Nutrient cycling, Fluctuations, Water quality, Benthic environment, Reservoirs.

The term spiralling refers to the coupled processes of cycling and downstream transport of nutrients. The intuitive notion of the spiral is, most simply, that of a nutrient cycle that fails to close in place in a stream, but rather is stretched by transport along the longitudinal axis of the stream. Two extreme modes have been characterized for spiralling in a lotic system, suggesting that real systems lie somewhere in between. At one extreme, the system is highly nutrient retentive, nutrients are neither depleted nor limiting, and therefore the spiralling of a nutrient plays no regulatory role. The headwater reaches of my hypothetical rivers approximate this mode. At the other extreme, the system is not retentive, nutrients are depleted to a limiting level, and therefore spiralling--or internal control over the form of downstream nutrient fluxes--plays a central role in mediating nutrient utilization. The model suggests that the transition to a nutrient-limited, transporting mode can be induced either through a single impoundment discharging plankton rich, nutrient poor water, or through a series of small regulatory impoundments whose primary effect is to slow the velocity of the river. This has two major practical implications: first, impoundment may reduce benthic activity, and perhaps total (water column plus benthic) productivity, as a result of nutrient depletion. Second, by inducing nutrient limitation, impoundments can produce a system in which response to nutrient loading is much greater than in the pristine benthic-dominated system. (See also W89-01736) (Lantz-PTT)
W89-01757

WATER TEMPERATURE CONTROL AND AREAL OXYGEN CONSUMPTION RATES AT A NEW RESERVOIR, AND THE EFFECTS ON THE RELEASE WATERS,

Army Engineer District, Portland, OR.

R. A. Cassidy, and P. E. Dunn.

IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 339-351, 9 fig, 2 tab, 16 ref.

Descriptors: *Water quality control, *Water temperature, *Oxygen, *Selective withdrawal, *Ecological effects, *Reservoirs, Regulated flow, Thermal pollution, Dissolved oxygen.

Use of a multiple level withdrawal structure at Applegate Lake has reduced the short-term harmful effects in the downstream river which are associated with a new reservoir. During the first year of impoundment, when significant water quality degradation can occur in a reservoir, water released through the selective withdrawal structure at Applegate Lake provided the receiving stream with summer water temperatures of 10 C to 15 C and reduced the development of a dissolved oxygen deficit. Although the dissolved oxygen concentrations in the reservoir during the first year of impoundment dropped to approximately 1 mg/L, the reservoir did not become completely anoxic. This achievement prevented by-products of anoxia, such as hydrogen sulfide gas, from being released downstream to subject the aquatic organisms in the regulated river system to physiological stress. (See also W89-01736) (Lantz-PTT)
W89-01759

CHEMICAL AND BIOLOGICAL CHANGES IN THE TER RIVER INDUCED BY A SERIES OF RESERVOIRS,

Barcelona Univ. (Spain). Dept. de Ecologia.

For primary bibliographic entry see Field 6G.
W89-01762

ST. CLAIR RIVER AND LAKE ST. CLAIR, MICHIGAN: AN ECOLOGICAL PROFILE,

Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.

T. A. Edsall, B. A. Manny, and C. N. Raphael.

Fish and Wildlife Service, Washington, DC. Biological Report 85(7.3), April 1988. 130p, 75 fig, 40 tab, 218 ref.

Descriptors: *St. Clair River, *Lake St. Clair, *Michigan, *Ecosystem, Wetlands, Flora, Fauna, Fishing, Waterfowl, Navigation, Water pollution effects, Biological studies, Ecology.

The St. Clair system is an extremely valuable resource that provides quality recreational opportunities to many people in southeast Michigan and the bordering areas of Ontario. Much of the St. Clair Delta remains in its natural state and more than 42,000 acres of wetlands in the delta support a large and diverse flora and fauna. The St. Clair system is heavily used by recreational boaters, waterfowl hunters, and anglers. Fishing through the ice is a popular winter activity in some parts of the system. The waters of the St. Clair system are also used for navigation and for the disposal of municipal and industrial wastes, while the shorelines support industrial and residential development and agriculture. Recognition of potentially severe use conflicts has focused concern on preparation by Michigan and Ontario of Remedial Action Plans designed to control pollution by toxic substances and restore all beneficial uses to each affected area, consistent with a continued, multiple-use philosophy for the system. This profile is a synthesis of available information on this waterway, especially information pertinent to managing the biological resources of the river and lake. Information gaps are identified and accommodated by reference to research done elsewhere or to management plans for other similar rivers and lakes. Wherever possible, the river and lake are described from a systems viewpoint as an intact, integrated unit of the Great Lakes ecosystem. (Lantz-PTT)
W89-01770

WILDLIFE PROTECTION, MITIGATION, AND ENHANCEMENT PLAN, PALISADES PROJECT,

Idaho Dept. of Fish and Game, Boise.

For primary bibliographic entry see Field 5G.
W89-01771

INSTREAM FLOWS NEEDED FOR SUCCESSFUL MIGRATION SPAWNING AND REARING OF RAINBOW AND WESTSLOPE CUTTHROAT TROUT IN SELECTED TRIBUTARIES OF THE KOOTENAI RIVER,

Montana Dept. of Fish, Wildlife and Parks, Kalispell.

B. Marotz, and J. Fraley.

Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009904. Price codes: A06 in paper copy, A01 in microfiche. DOE Report No. DOE/BP/23666--1, December 1986. Final Report. 177p, 61 fig, 42 tab, 19 ref, 3 append. DOE Contract DE-AI79-85BP23666. Bonneville Power Administration BPA 85-6.

Descriptors: *Fish migration, *Spawning, *Rainbow trout, *Cutthroat trout, *Instream flow, *Water demand, *Kootenai River, Trout, Fisheries, Fish populations, Bristow Creek, Quartz Creek, Water temperature, Pike Creek, Detritus.

The Kootenai River fishery is threatened by microhydro and other water use development which reduce tributary habitat critical for maintaining a healthy spawning and rearing environment. Electrofishing in stream reaches where instream flow measurements were made indicates the relative recruit production value of the various streams. Of all reservoir tributaries investigated, Bristow Creek contained the greatest number of trout (Salmo spp. > or = 75 mm) per km (12,179 + or - 143). Quartz Creek, containing an estimated 853 + or - 438 Salmo spp. (> or = 75 mm) per km, ranked highest among the main stem Kootenai River tributaries. Migrant Salmo spp. utilizing Bristow and Quartz creeks during spring were captured and released through a bi-directional fish trap. Schnabel's multiple census estimate was used to quantify the total migrant populations. An estimated 285 adult fish (range 224 to 336, P > or = 0.95) migrated into Bristow Creek to spawn. Quart Creek was used by an estimated 280 migrants (range 177 to 444). The timing of the run correspond with increasing water temperatures in both creeks. Fluvial bull trout enter spawning areas in Grave, Quartz, and Pipe creeks during fall. A total of 24 large adult bull trout were captured and released while migrating into Quartz Creek. Kokanee salmon migrated during fall to spawn in the Tobacco River and its major tributaries, Fortine and Grave creeks, as well as the Fisher River and Libby Creek below Libby Dam. Log and debris jams are obstacles to migrant fish in Barron, Bobtail, Bristow, Deep, Fivemile, Pinkham, Pipe and Quartz creeks. Periodic debris removal may be needed to maintain access to spawning gravels. Sediment pollution and channel instability caused by man's activities in the Kootenai watershed continue to threaten the health of the fishery resource. (Lantz-PTT)
W89-01775

BIOLOGICAL AND PHYSICAL INVENTORY OF THE STREAMS WITHIN THE NEZ PERCE RESERVATION: JUVENILE STEELHEAD SURVEY AND FACTORS THAT AFFECT ABUNDANCE IN SELECTED STREAMS IN THE LOWER CLEARWATER RIVER BASIN, IDAHO,

Nez Perce Tribe, Lapwai, ID. Fisheries Resource Management.

P. A. Kucera, and D. B. Johnson.

Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009919. Price codes: A10 in paper copy, A01 in microfiche. DOE Report No. DOE/BP/10068--T1, August 1986. 252 p, 92 fig, 53 tab, 62 ref, 2 append. DOE Contract DE-AI79-83BP10068. Project No. 82-1.

Descriptors: *Biological studies, *Steelhead trout, *Clearwater River, *Idaho, *Nez Perce Reservation, Streams, Fish, Trout, Biomass, Productivity,

Flow velocity, Water temperature, Seasonal variation, Fish migration, Smolt, Genetics.

A biological and physical inventory of selected tributaries in the lower Clearwater River basin was conducted by the Nez Perce Tribe Department of Fisheries Management during 1983 and 1984. The purpose of the juvenile steelhead study was to collect information for the development of alternatives and recommendations for the enhancement of the anadromous fish resources in streams on the Nez Perce Reservation. Five streams within the Reservation were selected for study: Bedrock and Cottonwood Creeks were investigated over a two years period (1983-1984) and Big Canyon, Jacks and Mission Creeks were studied for one year (1983). Biological information was collected and analyzed on the density, biomass, production and outmigration of juvenile summer steelhead trout. Physical habitat information was collected on available instream cover, stream discharge, stream velocity, water temperature, bottom substrate, embeddedness and stream width and depth. The present report focuses on the relationships between physical stream habitat and juvenile steelhead trout abundance. The downstream outmigration of juvenile steelhead principally occurred during the spring and fall periods. Fall pulses in downstream movement were generally reflected in short term increases in yearling fish densities at lower stream sampling stations. Abundance of yearling steelhead in the spring of 1984 (May-June) actually increased as the smolt outmigration was completed The redistribution of non-smolt age I+ fish into the sample station locations, apparently accounts for the increase. Genetic stock assessment of four Reservation stream steelhead populations indicated that two of the streams may have been affected by Dworshak Hatchery steelhead. The remaining two populations were more similar to steelhead from the grande Ronde, Imnaha and Salmon River systems. (Lantz-PTT)
W89-01776

IDAHO HABITAT EVALUATION FOR OFF-SITE MITIGATION RECORD: ANNUAL REPORT 1985,
Idaho Dept. of Fish and Game, Boise.
C. E. Petrosky, and T. B. Holubetz.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009921. Price codes: A10 in paper copy, A01 in microfiche. DOE Report No. DOE/BP/13381--2, April 1986. 285p, 37 fig, 78 tab, 56 ref, 3 append. DOE Contract DE-AI79-84BP13381. Project No. 83-7.

Descriptors: *Idaho, *Clearwater River, *Fish populations, *Salmon River, *Environmental effects, Steelhead trout, Salmon, Water use, Sedimentation, Aquatic habitats, Water quality, Smolt, Fisheries.

The Idaho Department of Fish and Game (IDFG) conducted an evaluation of existing and proposed habitat improvement projects for anadromous fish in the Clearwater River and Salmon River drainages during 1984 and 1985. Projects included in the evaluation are funded by or proposed for funding by the Bonneville Power Administration under the Northwest Power Planning Act. The Clearwater River and Salmon River drainages account for virtually all of Idaho's wild and natural production of summer steelhead and spring and summer chinook salmon, as well as a remnant run of sockeye salmon. Although a majority of the habitat still available to steelhead and salmon is high quality, man's activity in Idaho has degraded many streams. Sedimentation has increased with widespread logging, road building, and associated activities. Intensive livestock grazing near streams has removed riparian vegetation, changed stream morphology, and accelerated soil erosion. Mining has had profound effects in parts of the drainages through stream channel alterations, discharge of toxic effluents, and increased sedimentation. Irrigation withdrawals have reduced flows and increased water temperatures, often to critical levels for steelhead and salmon during summer. Primary objectives of this evaluation project are to: (1) document physical changes that result from habitat enhancement; (2) measure changes in steelhead and chinook parr/smolt production attributable to all habitat enhancement projects; (3) determine project effectiveness to guide future enhancement activity, and (4) determine benefits in terms of increased smolt and adult production resulting from each habitat enhancement project. General level studies on each project will provide a large database that can be used to predict response of increased or decreased fish production from a physical change in anadromous fish habitat. This data should assist sponsors of future habitat enhancement projects in more accurately estimating fishery benefits of their proposed projects. This database will also assist in defining limiting habitat factors for the various types of streams in Idaho. (Lantz-PTT)
W89-01777

EVALUATION OF THE USE OF COMMUNITY SIMILARITY TECHNIQUES AS APPLIED TO PHYTOPLANKTON COMMUNITIES,
Kansas Univ., Lawrence.
D. C. Reinke.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 6-17, 16 tab, 10 ref.

Descriptors: *Phytoplankton, *Ecosystems, *Species composition, *Similarity index, Performance evaluation, Comparison studies, Species, Diversity, Biomass, Statistical studies, Ecology.

Seven community similarity indices were compared using a manipulated data set with known changes and an experimental data set of phytoplankton community data. Community similarities were calculated based on: (1) strict number of individuals per species, and (2) corrected for species size with an estimate of total biomass. The similarity techniques used in this study were heavily affected by the abundant species, and changes in the minor taxa were frequently undetectable. Two of the seven statistics were previously unpublished modifications of the Percent Similarity method of Whittaker, which were specifically modified to enhance the sensitivity to changes in low frequency species and proportional changes. While complex numerical techniques are commonplace in ecological literature, there is no generally accepted mathematical definition of community similarity. Ideally community comparison techniques should be sensitive to the loss or gain of a species and to changes in abundance of low and high frequency taxa. They should also detect proportional changes. None of the community similarity techniques used in this study fulfilled all the above requirements completely. All the similarity techniques assigned similarity values based on the presence of individuals. Perfect replication of cell counts for scarce species added little or nothing to the similarity values. At this time, a combination of statistical techniques using both numbers per taxa and an estimate of total biomass per taxa is recommended for the analysis of phytoplankton community data. (See also W89-01783) (Author's abstract)
W89-01784

WETLANDS,
Ohio State Univ., Columbus. School of Natural Resources.
W. J. Mitsch, and J. G. Gosselink.
Van Nostrand Reinhold Co., New York. 1986. 5392p.

Descriptors: *Wetlands, *Ecosystems, Coastal marshes, Wetland management, Tide lands, Swamps, Marshes.

Wetlands of North America are considered in this textbook with emphasis on the wetlands of the United States. A dual picture is presented of wetland ecology: (1) a general view of principles and components of wetlands that have broad application to many wetland types; and (2) an ecosystem view of wetlands that looks in detail at the structure and function of dominant wetland types. The text is divided into five parts: (1) Introduction; (2) The Wetland Environment; (3) Coastal Wetland Ecosystem; (4) Inland Wetland Ecosystems; and (5) Management of Wetlands. (See also W89-01783) (Lantz-PTT)
W89-01800

INVERTEBRATE FISH FOOD RESOURCES OF LOTIC ENVIRONMENTS,
Environmental Protection Agency, Washington, DC.
L. E. Keup.
Instream Flow Information Paper No. 24. Fish and Wildlife Service Biological Report 88(13), June 1988. 96 p, 9 fig, 10 tab, 107 ref, 2 append.

Descriptors: *Invertebrates, *Fish food, *Instream flow, *Water demand, *Limnology, *Lotic environment, Food chain, Fish, Ecosystems, Rivers, Aquatic plants, Detritus.

Fish are the aquatic ecosystem's end product harvested by man. Food supply may regulate the production of fish. This report deals with analysis and evaluation of fish food stocks. The scope is limited to river habitats and their invertebrate supplies of food. Information is most applicable to smaller streams or rivers--up to mean annual discharges of approximately 1,000 cfs. Emphasis is placed on the macroinvertebrate (visible to the naked eye) food animals. These are the primary food items of the carnivorous sport and food fishes (e.g., trout, bass, etc.) that are of high management interest. Three main sections discuss: (1) the habitat of fish food animals; (2) the 'drift' phenomenon; and (3) the effects of flow on the habitat and organisms. Aquatic vegetation, logs, or debris in a stream increase the physical habitat available for benthic animals. A method is presented to estimate the area of habitat available from tree remains in a stream. A 'key' is presented to aid managers in a cursory examination of fish and fish food information. The key assists in narrowing the range of potential problems managers need to consider in evaluating a river's biological resources. (Author's abstract)
W89-01802

DETROIT RIVER, MICHIGAN: AN ECOLOGICAL PROFILE,
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
B. A. Manny, T. A. Edsall, and E. Jaworski.
Fish and Wildlife Service Biological Report 85(7.17), April 1988. 86p, 30 fig, 41 tab, 220 ref.

Descriptors: *Detroit River, *Aquatic environment, *Ecosystems, *Michigan, Lake Huron, Lake Erie, Nutrients, Fish, Hydrological studies, Waterfowl, Wetlands, Ecological effects, Wastewater disposal, Water pollution effects, Water quality, Great Lakes.

A part of the connecting channel system between Lake Huron and Lake Erie, the Detroit River forms an integral link between the two lakes for both humans and biological resources such as fish, nutrients, and plant detritus. This profile summarizes existing scientific information on the ecological structure and functioning of this ecosystem. Topics include the geological history of the region, climatic influences, river hydrology, lower trophic-level biotic components, native and introduced fishes, waterfowl use, ecological interrelationships, commercial and recreational uses of the river, and current management issues. Despite urbanization, the river still supports diverse fish, waterfowl, and benthic populations. Management issues include sewer overflows; maintenance dredging for navigation and port activities; industrial discharges of potentially hazardous materials; and wetland, fishery, and waterfowl protection and enhancement. (Author's abstract)
W89-01806

RECOMMENDED BIOLOGICAL INDICES FOR 301(H) MONITORING PROGRAMS,
Environmental Protection Agency, Washington, DC. Office of Marine and Estuarine Protection.
For primary bibliographic entry see Field 7B.
W89-01812

ASTM STANDARDS ON MATERIALS AND ENVIRONMENTAL MICROBIOLOGY.
American Society for Testing and Materials, Philadelphia, PA.
American Society for Testing and Materials, Philadelphia, Pennsylvania. 1987. 307p.

Descriptors: *Standards, *Water analysis, *Microbiological studies, *Materials, Regulations, Public health, Biodegradation, Biological treatment.

This volume of ASTM standards focuses on materials that were of interest to individuals of the ASTM Subcommittee E35.15 on antimienobial agents (such as wood, paper, adhesives, or paints), with test methods for specific microorganisms (such as water or air), or with test methods for evaluating biocides (such as cosmetic or process water). The specific focus of this book is: general methodology; test methods for specific microorganisms; microbiological contamination and biodeterioration assessment; human contact/public health; and materials and process protection by preservative or biocide use. (Lantz-PTT)
W89-01826

ECOLOGICAL CONSIDERATIONS IN WETLANDS TREATMENT OF MUNICIPAL WASTEWATERS.
For primary bibliographic entry see Field 5D.
W89-01827

WETLAND SYSTEMS FOR WASTEWATER TREATMENT: ENGINEERING APPLICATIONS,
Ramlit Associates, Inc., Berkeley, CA.
For primary bibliographic entry see Field 5D.
W89-01828

DESIGN AND USE OF ARTIFICIAL WETLANDS,
Ontario Ministry of the Environment, Toronto. Policy and Planning Branch.
I. Wile, G. Miller, and S. Black.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 26-37, 3 fig, 2 tab, 7 ref.

Descriptors: *Artificial wetlands, *Wastewater treatment, *Wetlands treatment, Hydraulic loading, Land use, Site selection, Hydraulic detention time, Insect control.

The use of wetlands for wastewater treatment has received increasing attention in North America. To date, attention has largely focused on the use of natural wetlands for tertiary treatment. Artificial wetlands, however, offer greater scope for general use and are not restricted by many of the environmental concerns and user conflicts associated with natural wetlands. Unlike natural wetlands, which are confined by availability and proximity to the sewage source, engineered marshes can be built anywhere, including lands with limited alternative uses. They also offer greater scope for design and management options and thus may provide superior performance and reliability. Use of artificial wetlands for year-round treatment of sewage has been under study in Ontario since 1979. An experimental facility in Listowel, Ontario, consists of five separate marsh systems and provides flexibility in pretreatment (conventional lagoon; complete-mix aerated cell), system configuration, hydraulic loading rates, liquid depths, and detention times. Data from this facility has been used to develop preliminary design and management guidelines. Design considerations such as: site selection, pretreatment, vegetation, marsh configuration, hydraulic loading/detention time, and land requirements, are one focus of discussion. A second focus is management considerations (i.e. hydraulic detention time, harvesting of vegetation, resources recovery and pest control). (W89-01827) (Lantz-PTT)
W89-01829

MOSQUITO CONSIDERATIONS IN THE DESIGN OF WETLAND SYSTEMS FOR THE TREATMENT OF WASTEWATER,
Dewante and Stowell, Sacramento, CA.
For primary bibliographic entry see Field 5D.
W89-01830

CONSIDERATIONS FOR WETLAND TREATMENT OF SPENT GEOTHERMAL FLUIDS,
CH2M, Inc., Portland, OR.
For primary bibliographic entry see Field 5D.
W89-01831

ECOLOGICAL PERSPECTIVES ON WETLAND SYSTEMS,
Wisconsin Univ.-Milwaukee. Dept. of Botany.
G. R. Guntenspergen, and F. Stearns.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 69-97, 177 ref. NSF Grant DEB 791 2516.

Descriptors: *Wetlands, *Ecological effects, *Wastewater treatment, *Water pollution effects, Literature reviews, Nutrients, Environmental effects, Artificial wetlands, Economic aspects.

An attempt was made to find common factors among processes in different wetland types. The universal presence of water--although under a variety of hydrologic regimes--helps to generate the diversity of wetlands seen. Wetland species have adapted in different ways to the variables that force wetland processes, with the result that each wetland requires individual consideration. Some short-term studies have shown wetlands to be effective in improving the quality of effluent discharges with few adverse effects. However, this evidence is equivocal. In the long term, the use of wetlands for such purposes may be counterproductive. If a wetland changes as a result of effluent addition (i.e., both nutrients and water), the new steady state that is achieved may not meet the desired goal of filtering nutrients and other pollutants and/or maintaining the traditional wetland values. If wetlands are to be maintained for a variety of uses, caution must be exercised concerning the inputs imposed on them. The effluent addition on wetland function are considered. Changes occur, but because of the obvious individuality of wetlands, it is difficult to predict the responses exactly or to generalize about them. Too little is known about these systems to permit realistic judgments to be made concerning the economic and environmental trade-offs. One way to understand the relationship between wetland structure, function, and effluent discharge better is to construct artificial systems and model these interactions. Such systems can be easily manipulated and different variables isolated and monitored. (See also W89-01827) (Lantz-PTT)
W89-01832

WATER CONSERVATION WETLAND VALUES,
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
H. T. Odum.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 98-111, 7 fig, 1 tab, 21 ref.

Descriptors: *Wetlands treatment, *Economic aspects, *Wastewater treatment, *Water conservation, *Wetlands, Energy, Environmental management, Value, Ecosystems.

The water-wetland system may be summarized with an energy circuit diagram that is both a kinetics model and an energy-accounting network. Water is used for photosynthesis and transpired in the process. Central to the valuation of wetlands is the concept of embodied energy. As energy flows through successive compartments, the original solar energy is transformed to energy of higher organization and quality but less caloric quantity. The increasing value of water by virtue of its convergence to higher quality is measured by the energy transformation ratio (global solar calories used per calorie of higher-quality type delivered). With successive steps of use and value added as the environmental product is transferred and transformed through successive steps, more energy is used at each step to accomplish the next, and so on. The dollars paid to a human who first brings the free resource into the economy are a very small part of the ultimate work accomplished. The dollar circulation ultimately stimulated can be estimated by the proportion that the water's embodied energy is of the total embodied energy of the economy. This is the proportion of the Gross National Product (GNP) due to that contribution. Wetlands have very high embodied energy and higher contributions to economic dollar circulation than those of many other ecosystems because of their role in converging the embodied energy of water. Water has higher dollar values to an economy than usually assigned when only human processing costs are considered. This is a larger value than the microeconomic price. Wetlands are valuable because many of them conserve water and filter recharging waters. Wetlands are especially valuable for wastewater recycling because they are solar energy driven, self-maintaining, and self-organizing. Thus they are very appropriate to the times and to the ideals of ecological engineering as first developed with the multiple seeding principle in microcosms. (See also W89-01827) (Lantz-PTT)
W89-01833

ENERGY FLOW IN WETLANDS,
Massachusetts Univ., Amherst. Dept. of Forestry and Wildlife Management.
For primary bibliographic entry see Field 5D.
W89-01834

COMPARISONS OF THE PROCESSING OF ELEMENTS BY ECOSYSTEMS, I: NUTRIENTS,
Cornell Univ., Ithaca, NY. Ecosystems Research Center.
J. R. Kelly, and M. A. Harwell.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 137-157, 10 fig, 2 tab, 26 ref. EPA Contract CR 807856 01.

Descriptors: *Wetlands, *Wastewater treatment, *Phosphates, *Fate of pollutants, *Ecosystems, *Wastewater disposal, *Nutrients, Cycling nutrients, Nitrogen, Phosphorus, Land disposal, Wetlands.

A comparison of nutrient-processing characteristics of ecosystems can be made by looking at input/output relationships. Since gaseous N exchanges have not been quantified, a large number of 'natural' sites, especially terrestrial forests, appear from the data that are available to retain at least 50% of the N input. Addition of a considerable amount of N with sewage or other nutrient applications to terrestrial systems and wetlands does not change the gross pattern of input/output relationships observed. Added inputs to these ecosystems are accompanied by added outputs, resulting in a shift to parallel the ecosystems receiving inputs of an equal magnitude. P input/output relationships differ somewhat from the patterns for N. Many studies involve PO4 estimation, rather than total P; both are reported here. While a number of ecosystems retain a large proportion of P inputs, many appear to be nearly flow-through systems. Terrestrial systems exhibit quite thorough removal of added PO4 prior to water outflow, dramatically demonstrated by the horizontal shift along the input axis from natural to enriched sites. This terrestrial retention would not have been predicted simply from knowledge of the natural ecosystem's processing capability. Finally, wetlands vary broadly in the processing efficiency of added P, ranging across an order of magnitude in percent retention. (See also W89-01827) (Lantz-PTT)
W89-01836

COMPARISONS OF THE PROCESSING OF ELEMENTS BY ECOSYSTEMS, II: METALS,
Marine Biological Lab., Woods Hole, MA.
For primary bibliographic entry see Field 5D.
W89-01837

EFFECT OF NATURAL HYDROPERIOD FLUCTUATIONS ON FRESHWATER WETLANDS RECEIVING ADDED NUTRIENTS,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5D.
W89-01838

SIGNIFICANCE OF HYDROLOGY TO WETLAND NUTRIENT PROCESSING,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-01839

EFFECTS OF WASTEWATER ON WETLAND ANIMAL COMMUNITIES,
Lake Michigan Federation, Chicago, IL.
For primary bibliographic entry see Field 5C.
W89-01840

VEGETATION IN WETLANDS RECEIVING SEWAGE EFFLUENT: THE IMPORTANCE OF THE SEED BANK,
Smithsonian Environmental Research Center, Edgewater, MD.
For primary bibliographic entry see Field 5D.
W89-01842

PUBLIC HEALTH IMPLICATIONS OF SEWAGE APPLICATIONS ON WETLANDS: MICROBIOLOGICAL ASPECTS,
Massachusetts Univ. at Boston. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W89-01843

WILDLIFE HEALTH IMPLICATIONS OF SEWAGE DISPOSAL IN WETLANDS,
National Wildlife Health Lab., Madison, WI.
For primary bibliographic entry see Field 5E.
W89-01844

MICROBIOLOGICAL STUDIES OF MUNICIPAL WASTE RELEASE TO AQUATIC ENVIRONMENTS,
Maryland Univ., College Park. Dept. of Microbiology.
For primary bibliographic entry see Field 5D.
W89-01845

MICROBIAL TRANSFORMATIONS OF DETRITAL CARBON IN WETLAND ECOSYSTEMS: EFFECTS OF ENVIRONMENTAL STRESS,
Georgia Univ., Athens. Dept. of Microbiology.
For primary bibliographic entry see Field 5D.
W89-01846

LONG-TERM IMPACTS OF AGRICULTURAL RUNOFF IN A LOUISIANA SWAMP FOREST,
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 4C.
W89-01848

MISSISSIPPI RIVER DELTA: A NATURAL WASTEWATER TREATMENT SYSTEM,
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 5D.
W89-01849

AGING PHENOMENA IN WASTEWATER WETLANDS,
Michigan Univ., Ann Arbor. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W89-01850

ECOLOGICAL EVALUATION PROCEDURE FOR DETERMINING WETLAND SUITABILITY FOR WASTEWATER TREATMENT AND DISCHARGES,
Southeast Wisconsin Regional Planning Commission, Waukesha.
For primary bibliographic entry see Field 5D.
W89-01852

MANAGEMENT POTENTIAL FOR NUTRIENT REMOVAL IN FORESTED WETLANDS,
East Carolina Univ., Greenville, NC. Dept. of Biology.
For primary bibliographic entry see Field 5D.
W89-01853

WETLAND-WASTEWATER ECONOMICS,
Williams and Works, Grand Rapids, MI.
For primary bibliographic entry see Field 5D.
W89-01854

USE OF WETLANDS FOR WASTEWATER TREATMENT AND EFFLUENT DISPOSAL: INSTITUTIONAL CONSTRAINTS,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5D.
W89-01855

RESPONSES OF WETLANDS AND NEIGHBORING ECOSYSTEMS TO WASTEWATER,
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
For primary bibliographic entry see Field 5C.
W89-01856

WETLANDS, WASTEWATER, AND WILDLIFE,
Utah State Univ., Logan. Dept. of Wildlife Science.
For primary bibliographic entry see Field 5C.
W89-01857

WETLANDS FOR WASTEWATER TREATMENT: AN ENGINEERING PERSPECTIVE,
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 5D.
W89-01858

AQUATIC BIOLOGY AND HYDROELECTRIC POWER DEVELOPMENT IN NEW ZEALAND.
For primary bibliographic entry see Field 6G.
W89-01871

LAKE LEVEL CONTROL,
Otago Univ., Dunedin (New Zealand). Dept. of Botany.
A. F. Mark.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 113-123, 3 fig, 1 tab, 3 plates, 10 ref.

Descriptors: *Lakes, *Water level, *Water level fluctuations, *New Zealand, Surface water, Water control, Ecological effects, Shoreline cover, Vegetation, Case studies, Sediments.

Lakes are a distinctive features of New Zealand's dynamic landscape. Like most other landscape features, lakes are subject to natural processes which are occasionally catastrophic. Natural catastrophes, however, are rare. Indeed most lakes in their natural state have developed a dynamic equilibrium between the variation in water level and associated wave regimes, and the physical and biological features of their shorelines. Yet many of New Zealand's lakes, especially the larger ones, have had their levels manipulated artificially in order to control their outflow or increase their storage and/or head of water, usually for hydroelectric generation but occasionally for irrigation, or more rarely for both. Others have been created for similar purposes as with the Cobb dam in north-west Nelson, Moawhango dam south-east of Ruapehu in the headwaters of the Rangitikei, Lake Mahinerangi on the eastern Otago uplands or the series on the Waitaki River along the Otago-Canterbury border. At least one lake, Ohia in Northland, that was destined for reservation because of its scientific value (preserving intact root systems of an ancient kauri forest), has been virtually lost as part of agricultural development. This chapter examines the implications of lake level fluctuations on shoreline vegetation and sediments, particularly in terms of ecological tolerances and lakeshore stability. (See also W89-01871) (Lantz-PTT)
W89-01881

MEASURES TO BENEFIT WETLAND BIRDS,
Ministry of Agriculture and Fisheries, Dunedin (New Zealand).
J. M. Neilson.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 168-179, 2 plates, 16 ref.

Descriptors: *Wetlands, *Birds, *Environmental protection, *Ecosystems, *Reservoirs, Hydroelectric plants, Wildlife, Species diversity, Waterfowl, Lakes, Rivers.

The construction of reservoirs frequently occurs at the expense of a river-dwelling and adapted bird fauna. Dams are replacement habitats consisting of large and often regular shaped bodies of water which provide opportunities for the establishment of bird groups different from those supplanted by the reservoir. The wildlife manager's challenge is to determine by which methods these new, or expanded, water bodies can best be managed to provide for a new and diverse bird fauna. Habitat improvement measures for birdlife can increase the numbers and diversity of birds using reservoirs and immediate environs, or those using downstream residual river systems. This chapter identifies the habitat needs of different groups of wetland dependent birds and suggests ways by which hydro-impoundments may be enhanced to benefit wetland birds. (See also W89-01871) (Lantz-PTT)
W89-01885

PREDICTION OF PHYTOPLANKTON ABUNDANCE AND ITS EFFECT ON WATER QUALITY,
Ministry of Works and Development, Hamilton (New Zealand). Water Quality Centre.
R. A. Hoare, R. D. Pridmore, and W. N. Vant.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 180-191, 3 fig, 1 tab, 33 ref.

Descriptors: *Phytoplankton, *Chlorophyll a, *Water quality, *Limnology, *Reservoirs, Phosphorus, Hydraulic properties, Hydraulic retention time, Turbidity, Suspended solids, Algae.

Phytoplankton abundance (measured as chlorophyll a) can be predicted for new impoundments from estimates of phosphorus concentrations in the inflows, and the hydraulic properties of the impoundments. The actual concentration found is influenced unpredictably by many factors peculiar to each impoundment, so that there is a 30% probability that actual chlorophyll concentrations will be greater than twice the predicted value or less than half of it. If the hydraulic retention time of the impoundment is short (i.e., less than a few weeks) the prediction methods given here should not be used at all. The appearance of the water (i.e., its clarity), can be determined by the effects of the phytoplankton, but is can also be expected that it will frequently be controlled by inorganic suspended solids, or other non-algal constituents, such as dissolved color. At present, there are no well established methods for predicting the amounts of these materials in impoundments. (See also W89-01871) (Lantz-PTT)
W89-01886

PERIPHYTON,
Ministry of Works and Development, Christchurch (New Zealand). Hydrology Centre.
B. J. F. Biggs.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 192-206, 3 fig, 2 tab, 59

ref.

Descriptors: *Periphyton, *Environmental effects, *Algae, *Aquatic plants, *Epiphytes, *Rivers, Reservoirs, Lakes, Biodegradation, Filtration, Absorption, Hydroelectric plants, Ecological effects.

The algal periphyton is subdivided according to the nature of the substrate on which it grows (e.g. communities growing on rocks are called 'epilithic'; on higher plants, 'epiphytic'; on mud and sand, 'epipelic'), and it ranges in structure from a fine invisible film to beds of long filaments covering the bottom of rivers. In open river systems the algal periphyton may be the main source of energy for higher biological communities such as benthic invertebrates. The periphyton also plays a major role in purification of water, acting as a physical filter of particulate matter; a site for bacterial breakdown of organic wastes; absorbing some waste constituents; and by releasing oxygen. Where physical conditions are suitable (e.g. low summer flows and stable river bed sediments) and where inorganic nitrogen and phosphorus enrichment occurs, they may proliferate, forming dense green mats. These mats may degrade water quality through diel fluctuations in pH and dissolved oxygen, clog water abstraction structures, and be aesthetically undesirable. Hydroelectric impoundments usually have major impacts on freshwater environments through converting a riverine ecosystem to a lake ecosystem. Internationally, there appear to have been few studies on the impacts of hydroelectric power development on periphyton. The nature of communities in a number of reservoirs has been documented and some quantitative studies have been carried out on communities in rivers downstream of power developments. This chapter reviews this information, and more general ecological studies, to highlight changes that occur to periphyton with the construction and management of hydroelectric power stations. These studies have all documented proliferations of periphyton below impoundments; one also found major differences in community type compared with nonregulated areas. Bryophytes and filamentous green algae were the most favored groups of organisms. (See also W89-01871) (Lantz-PTT)
W89-01887

AQUATIC MACROPHYTES,
Ministry of Energy, Dunedin (New Zealand). Electricity Div.
For primary bibliographic entry see Field 6G.
W89-01888

INVERTEBRATES,
Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
For primary bibliographic entry see Field 6G.
W89-01889

WETLAND BIRDS,
Ministry of Agriculture and Fisheries, Christchurch (New Zealand).
K. F. D. Hughey.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 264-275, 4 fig, 2 plates, 26 ref.

Descriptors: *Wetlands, *Birds, *Waterfowl, *New Zealand, *Water resources development, Rivers, Aquatic animals, Ducks, Wrybills, Terns, Black stilts, Ecosystems, Flood control, Channels, Hydroelectric plants.

A diverse range of bird species and bird communities occupy riverine environments in New Zealand. Some river-dwelling species are highly endangered, e.g. black stilts on braided rivers, while others are considered to be threatened: e.g. wrybills, black-fronted terns, and banded dotterels also on braided rivers, and blue ducks on upland single channel rivers. Birds of braided riverbeds are susceptible to the impact of hydroelectric power development as are blue ducks on single channel rivers. Apart from dams other impacts are linked with water abstraction for irrigation, channelization for flood control and property protection, vegetation encroachment and water pollution. This chapter identifies the different bird communities typical of New Zealand's main river types, examines current methods of impact assessment and evaluation for hydroelectric power dam development, describes the results being obtained from existing approaches and recommends where future work in New Zealand should be directed. (See also W89-01871) (Lantz-PTT)
W89-01891

FACTORS AFFECTING THE ACCEPTANCE AND REJECTION OF GENETICALLY ALTERED MICROORGANISMS BY ESTABLISHED NATURAL AQUATIC COMMUNITIES,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W89-01908

CHARACTERISTICS OF SOME LARGE-SCALE RESERVOIRS IN THE U.S. AND CANADA,
E. O. Gangstad, F. L. Nibling, and J. J. Sartoris.
IN: Environmental Management of Water Projects, CRC Press, Inc., Boca Raton, FL. 1987. p 27-34, 5 tab, 11 ref.

Descriptors: Fate of pollutants, *Aquatic weed control, Reservoirs, Canada, Multiple regression analysis, Dichlorophenoxyacetic acid, Water quality, Seasonal variation.

Reservoir and waterway data cooperatively assembled from a variety of governmental agencies in the U.S. and Canada are summarized. Contributors from the U.S. were the Tennessee Valley Authority (TVA), U.S. Army Corps of Engineers (Corps), and the Bureau of Reclamation (USBR). Information on lakes in British Columbia was furnished by the Ministry of Environment, British Columbia, Canada. Data on residues of 2,4-dichlorophenoxyacetic acid (2,4-D) used for Eurasian watermilfoil control in reservoirs in British Columbia, and TVA, Corps and USBR projects were subjected to stepwise multiple regression analysis. Results of this study showed that season, volume, and rate were highly significant. The depth of the reservoir (feet) and time after application (days) were not significant, i.e., they were adequately measured by the above variables. The standard application rate of 20 to 40 lb/acre did not produce 2,4-D residues in large reservoirs above the tolerance level of 100 ppb. (See also W89-01990) (Author's abstract)
W89-01992

BIOLOGICAL PARAMETERS OF THE TVA EURASIAN WATERMILFOIL MANAGEMENT PROGRAM,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 4A.
W89-01993

ECOLOGICAL PARAMETERS INFLUENCING AQUATIC PLANT GROWTH,
For primary bibliographic entry see Field 2E.
W89-01994

BIOLOGICAL PARAMETERS INFLUENCING GROWTH AND REPRODUCTION OF HYDRILLA,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 2E.
W89-01995

TOXIC CONTAMINATION IN LARGE LAKES. VOLUME I: CHRONIC EFFECTS OF TOXIC CONTAMIMANTS IN LARGE LAKES.
For primary bibliographic entry see Field 5C.
W89-02121

TOXIC CONTAMINATION IN LARGE LAKES. VOLUME II: IMPACT OF TOXIC CONTAMINANTS ON FISHERIES MANAGEMENT.
For primary bibliographic entry see Field 5C.
W89-02137

LAKE ORTA (N. ITALY): RECOVERY AFTER THE ADOPTION OF RESTORATION PLANS,
Istituto Italiano di Idrobiologia, Novara.
For primary bibliographic entry see Field 5G.
W89-02142

RIVERINE AND OTHER TROPICAL LAKES AND THEIR FISHERIES,
East-West Center, Honolulu, HI.
J. E. Bardach.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 131-150, 4 fig, 1 tab, 26 ref.

Descriptors: *Limnology, *Tropical regions, *Fisheries, *Lakes, *Water pollution effects, Aquaculture, Fish, Species diversity, Shallow water.

Large shallow lakes, mostly in the tropics and their flood plains include such water bodies as the Great Lake of Cambodia, Lake Chad and others, as well as China's largest fresh water lakes. They have been and are being affected by changes in water regimes related to population increases and shifts. The resulting fairly rapid alterations in availability of water, spatially and temporally, as well as pollution have greatly reduced fish production in these waters. It has even led to the loss of certain species. In view of the importance of fresh water fisheries in the nutrition of many millions of riparian dwellers, development of measures to cope with these changes are of great urgency. Traditional and still ongoing fisheries in large shallow lakes were often based on extensive aquaculture techniques which now cannot be practiced any more. Intensification of aquaculture is being advocated to make up for shortfalls in annual fish harvests. Obstacles to the realization of such measures, here to be treated also, are technical as well as economic and social. (See also W89-02137) (Author's abstract)
W89-02143

LAKE BIWA, ITS VALUE AND RELATION TO TRIBUTARY STREAMS,
Shiga Univ., Otsu (Japan).
S. Mori.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 151-168, 7 fig, 1 tab, 16 ref.

Descriptors: *Lake Biwa, *Japan, *Water pollution effects, *Lakes, *Path of pollutants, Gravel, Sediment transport, Nutrients, Herbicides, Heavy metals, Nitrogen, Phosphorus, Fate of pollutants.

Lake Biwa has an extraordinarily long history, between 2 and 3 million years, which indicates that this lake is the second or third oldest lake in the world and that it has been formed by repetition of land depressions and deposition of gravel or soil carried from the surroundings through tributary streams. Owing to this long history some organisms have developed characteristic habits, such as the fish Ayu or crucian carps. More than 460 streams flow into this lake. The main effects of these streams are: (1) sedimentation, and (2) carrying various contaminants, including nutrients, herbicides and heavy metals, to the lake. As for the nutrients, about 8,320 kg of total N and 878 kg of total P are conveyed daily to the lake, principally by streams. Because of regulation harmful influences from insecticides have remarkably decreased, but there is no prohibitive rule for herbicides. Heavy metals are uniformly deposited in the bottom sediments but no real injury is observed. (See also W89-02137) (Lantz-PTT)
W89-02144

EFFECTS OF CONTAMINANTS LOADINGS ON FISHERIES YIELDS FROM LARGE LAKES,
Ontario Ministry of Natural Resources, Thunder

Bay. Fisheries Research Section.
For primary bibliographic entry see Field 5C.
W89-02145

INDEXES FOR ASSESSING FISH BIOMASS AND YIELD IN RESERVOIRS,
Aquatic Ecosystem Analysts, Fayetteville, AR.
For primary bibliographic entry see Field 7C.
W89-02146

RESTOCKING OF GREAT LAKES FISHES AND REDUCTION OF ENVIRONMENTAL CONTAMINANTS 1960-1980,
Michigan State Univ., East Lansing.
For primary bibliographic entry see Field 8I.
W89-02148

FISHES, FISHING AND POLLUTION IN LAKE VANERN (SWEDEN),
Eco Research and Resource Planning, Bromma (Sweden).
For primary bibliographic entry see Field 8I.
W89-02149

PREDICTING, VALIDATING AND MONITORING EFFECTS OF TOXICS ON LARGE LAKE ECOSYSTEMS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
For primary bibliographic entry see Field 5C.
W89-02153

TOXIC CONTAMINATION IN LARGE LAKES. VOLUME III: SOURCES, FATE, AND CONTROLS OF TOXIC CONTAMINANTS.
For primary bibliographic entry see Field 5G.
W89-02155

CHEMICAL LIMNOLOGY OF PCBS IN LAKE SUPERIOR - A CASE STUDY,
Minnesota Univ., Minneapolis. Dept. of Civil and Mining Engineering.
For primary bibliographic entry see Field 5B.
W89-02172

ECONOMIC VIEW OF THE GREAT LAKES,
Center for the Great Lakes, Chicago, IL.
For primary bibliographic entry see Field 6A.
W89-02177

HISTORIC ROLE OF A LARGE LAKE IN JAPAN - THE CASE OF LAKE BIWA,
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
For primary bibliographic entry see Field 6G.
W89-02178

TRANSBOUNDARY MANAGEMENT OF LAKE GENEVA,
Republic et Canton de Geneve, Suisse. Dept. des Traveaux Publics.
For primary bibliographic entry see Field 6E.
W89-02180

MODEL-BASED EDUCATION SUPPORT SYSTEMS: APPLICATION TO LARGE LAKES AND HAZARDOUS WASTE MANAGEMENT,
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
For primary bibliographic entry see Field 6A.
W89-02181

LAKE RESOURCES AND FISHERIES UTILIZATION IN HUBEI PROVINCE,
Hubei Aquatic Products Science Research Inst. (China).
Y. M. Zhang.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 269-275, 1 tab.

Descriptors: *Lakes, *Water management, *Fisheries, *Hubei province, *Japan, Aquaculture, Regulations, Hydrologic regime, Fishing, Lake fisheries, Management planning.

There are 636 lakes in Hubei, China, province with a total area of 3000 square kilometers. The lakes are similar to each other in external and internal conditions. Since the natural environmental of lakes located in Hubei province is rather sample, the hydrological characteristics of each are almost the same. Fishing practices associated with a particular lake size can be divided into three types: (1) The majority of lakes are of the middle to large size (area > 30 sq km) and are grouped into the first lake type. Here, emphasis is placed on fishing the natural fish communities; (2) In the second type of lakes, the majority are medium-sized (area 7-30 sq km). They are part of extensive cultivation; (3) The third type of lake concerns those where intensive fish culturing as a result of extensive stocking is practiced. There are special institutions which are responsible for the management of fishing grounds. They are established for all lakes which have been utilized for fisheries. Responsibilities are as follows: (1) Making rules and regulations for breeding protection and fishing; (2) Producing fry and fingerlings to meet the needs for stocking; (3) Rehabilitation and protection of the fisheries environment; and (4) Managing the sale of the product, etc. (See also W89-02176) (Lantz-PTT)
W89-02193

YAKIMA RIVER SPRING CHINOOK ENHANCEMENT STUDY. ANNUAL REPORT FY 1986,
Colorado Dept. of Local Affairs, Denver.
For primary bibliographic entry see Field 8I.
W89-02260

2J. Erosion and Sedimentation

USE OF RADIOMETRIC (CS-137, PB-210), GEOMORPHIC, AND STRATIGRAPHIC TECHNIQUES TO DATE RECENT OXBOW SEDIMENTS IN THE RIO PUERCO DRAINAGE GRANTS URANIUM REGION, NEW MEXICO,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Chemistry.
For primary bibliographic entry see Field 4C.
W89-01320

DECLINE IN THE SUSPENDED LOAD OF THE LOWER MISSISSIPPI RIVER AND ITS INFLUENCE ON ADJACENT WETLANDS,
Louisiana State Univ., Baton Rouge. Dept. of Geography and Anthropology.
For primary bibliographic entry see Field 4C.
W89-01321

RIVER-BEND CURVATURE AND MIGRATION: HOW ARE THEY RELATED,
Florida State Univ., Tallahassee. Dept. of Geology.
D. J. Furbish.
Geology GLGYB, Vol. 16, No. 8, p 752-755, August 1988. 4 fig, 26 ref. National Science Foundation Grant DEB 80-12095.

Descriptors: *Channel morphology, Scour, *Meanders, *Geomorphology, Rivers, River flow, Hydraulic models, Mathematical models, River bends, Curvature, Migration, Beatton River, Canada, Flow velocity, Sedimentation, Sediment transport, Stream erosion.

The asymmetric velocity distribution that characterizes the flow field in river bends originates with acceleration induced by bend curvature. This influence of curvature is cumulative in the sense that the asymmetry, reflected by cross-channel displacement of the filament of high velocity, starts to develop at the bend entrance and increases downstream as far as the curvature of the bend is sustained. Local rates of bend migration measured normal to the channel centerline are then proportional to the local flow asymmetry. The average migration rate for a bend can be related to its average curvature by integrating the effects of curvature and associated bed forms over bend length. Published data for bends of the Beatton River, Canada, confirm that average migration rates increase monotonically with average curvature if bend length is taken into account. (Author's abstract)
W89-01336

HYDROLOGIC FACTORS TRIGGERING A SHALLOW HILLSLOPE FAILURE,
California Univ., Santa Cruz. Dept. of Earth Sciences.
For primary bibliographic entry see Field 2G.
W89-01363

PROGRESSIVE ALTERATION OF FINE SEDIMENT ALONG AN URBAN STORM DRAIN,
Exeter Univ. (England). Dept. of Geography.
A. H. Roberts, J. B. Ellis, and W. B. Whalley.
Water Research WATRAG, Vol. 22, No. 6, p 775-781, June 1988. 2 fig, 1 tab, 36 ref, 12 plates.

Descriptors: *Suspended sediment, *Storm drains, *Catchment areas, *Sediment properties, Particle abrasion, Cementation, Electron microscopy, London, England, Urban areas, Fuzzy analysis, Frequency distribution, Settling basins, Silica, Storm runoff, Sedimentation, Sediment grading, Statistics.

Progressive changes in size and surface texture were examined along a storm drain using an electronic particle counter and scanning electron microscopy. The catchment, in North West London (England), covered 420 ha and the storm sewer was 1740 m in total length with varying diameters and gradients. A Fuzzy Classification technique was used to analyze the micrographs. Particle size distributions were predominantly bimodal and could be explained by cementation by silica of individual particles into aggregates. The degree of particle abrasion and of cementation increased with the distance travelled downstream, making it possible to recognize new material entering from the surface by its lesser degree of abrasion. This relationship was interrupted by the presence in the storm drain of a settling pond, which played a significant role in allowing larger individual particles and aggregates to settle out. (Rochester-PTT)
W89-01457

AQUATIC SEDIMENTS,
Environmental Protection Agency, Chicago, IL. Environmental Services Div.
For primary bibliographic entry see Field 5B.
W89-01504

SEDIMENTATION OF A HETEROGRANULAR MIXTURE: EXPERIMENTAL LAMINATION IN STILL AND RUNNING WATER,
G. Berthault.
Comptes Rendus de l'Academie des Sciences (Series 2) CHDCAQ, Vol. 306, No. 11, p 717-724, March 21, 1988. 8 fig, 4 ref.

Descriptors: *Particle size, *Lotic environment, *Lentic environment, *Sedimentation, *Deposition, *Heterogranular sediments, Lamination, Flow, Flumes, Flow velocity.

The experiments demonstrate that in still water, continuous depositing of heterogranular sediments gives rise to laminae that disappear progressively as the height of the fall of particles into water, and apparently their size, increase. The first experiments used a mixture of two types of sand, one white and calibrated between 20-80 micrometers, the other, colored with methylene blue with calibrations increasing in size. It was poured into a rectangular tube filled first with 2 m of water, then 4.7 m of water. The flow varied from 35-170 cu cm per 5 min with 2 m of water; at 4.7 m it remained constant at 40 cu cm per min, then more slowly at 200-400 cu cm per hr. Lamination was present at a water depth of 2 m; at 4.7 m lamination was present only at the highest flow rates, and disap-

peared with increasing particle size. The direction of lamination formed by sediments falling on a slope was observed in an aquarium with a water depth of 1.1 m. Slopes of 6 degrees and 15 degrees were used. Laminae were parallel to the slope of the upper part of the deposit. In the final experiment, a recirculating flume with a water discharge rate of 16-70 l/sec was used. At speed greater than 0.4 m per sec, many closely related types of laminations appeared in the structure of the deposit. (Author's abstract)
W89-01511

SYNGENETIC ORIGIN OF GYPSUM CRYSTALS BEARING BACTERIAL CALCITE NEOFORMATION, DISCOVERED WITHIN SUSPENDED MATTER IN THE LOIRE RIVER ESTUARY,
Nantes Univ. (France). Lab. de Geologie Marine.
For primary bibliographic entry see Field 2L.
W89-01512

SAND RIGHTS: USING CALIFORNIA'S PUBLIC TRUST DOCTRINE TO PROTECT AGAINST COASTAL EROSION,
For primary bibliographic entry see Field 6E.
W89-01519

WEATHERING AND SOIL-FORMING PROCESSES,
Michigan State Univ., East Lansing. Dept. of Geological Sciences.
M. A. Velbel.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 93-102.

Descriptors: *Weathering, *Soil genesis, *Coweeta, *North Carolina, Geohydrology, Soil erosion, Erosion, Rock mechanics, Geochemistry, Mica, Garnet, Feldspar, Bedrock, Fluvial sediments.

Most weathering profiles of the Coweeta Hydrologic Laboratory comprise thin (to about 30 cm) A and B horizons atop substantial thicknesses (ave. about 6 m) of saprolite. Extensive isovolumetric weathering of rock to saprolite results in the landscape being covered by a porous, permeable blanket of weathered material which supplies streamflow as water drains slowly from it, and which is vulnerable to erosion by fluvial processes and landslides. Rock weathering to saprolite occurs primarily via weathering of three major rock-forming minerals: biotite mica, almandine garnet, and plagioclase feldspar. Geochemical mass-balance calculations permit quantification of mineral weathering rates and rates of geomorphically significant saprolitization. Mineral weathering rates determined for Coweeta WS 27 compare favorably with mineral weathering rates determined in laboratory experiments under similar hydrogeochemical conditions. One major source of uncertainty in this comparison of field with laboratory rates is the difficulty in estimating reactive surface area of the minerals in natural systems. Provided that future research resolves this difficulty, it should become practical to use carefully constrained laboratory experiments to estimate rates of elemental transfer in natural weathering systems. Transformation of bedrock to saprolite (saprolization) presently prepares the landscape for erosion at a rate equal to the long-term average denudation rate for the southern Appalachians (4 cm/1000 yrs), suggesting that dynamic equilibrium of the landscape prevails in the long term. In the (geologically) short term, erosion at the top of the profile is much more sporadic. Present rates of erosion by normal fluvial processes suggest that high-magnitude, low-frequency geomorphic events accomplish most of the short-term erosion required to maintain long-term geomorphic equilibrium of the southern Blue Ridge landscape. (See also W89-01691) (Lantz-PTT)
W89-01697

DEBRIS AVALANCHE AND THE ORIGIN OF FIRST-ORDER STREAMS,
Emory Univ., Atlanta, GA. Dept. of Geology.
For primary bibliographic entry see Field 8E.
W89-01698

PHYSICS OF SEDIMENT TRANSPORT, RESUSPENSION, AND DEPOSITION,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
J. R. Bennett.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 5-12, 10 fig, 10 ref.

Descriptors: *Sediment transport, *Suspended sediments, *Sedimentation, *Lake Ontario, *Lake Michigan, *Lake Erie, *Path of pollutants, Ekman layer, Recycling.

Many long-lived pollutants become attached to particles in the water and eventually find their way to the sediments of lakes, rivers, harbors, and oceans. In some cases, this can accelerate the removal of the pollutants from the ecosystem. In other cases, for example harbors where dredged materials are disposed of on land, it can lead to a recycling of the materials to their source - people. The general problem, resuspension and deposition, is described and then emphasis is given to recent quantitative research in Lakes Ontario, Michigan and Erie. Original calculations are presented to show that Ekman layer sediment transport is important in determining the deposition areas in deep lakes. (See also W89-01714) (Lantz-PTT)
W89-01715

SEDIMENTS AS A SOURCE FOR CONTAMINANTS,
Waterloopkundig Lab. te Delft (Netherlands).
For primary bibliographic entry see Field 5B.
W89-01716

SOCIAL AND HUMAN RELEVANCE OF IN SITU SEDIMENTS,
Moncton Univ. (New Brunswick). Faculty of Social Sciences.
For primary bibliographic entry see Field 6G.
W89-01726

NATURAL SILTATION OF BROWN TROUT (SALMO TRUTTA L.) SPAWNING GRAVELS DURING LOW-FLOW CONDITIONS,
Freshwater Biological Association, Ambleside (England).
P. A. Carling, and C. P. McCahon.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 229-244, 8 fig, 24 ref.

Descriptors: *Silt, *Sedimentation, *Trout, *Spawning, *Streamflow, *Stream biota, *Gravel, Ecological effects, Suspended sediment, Fish, Particle size.

Both suspended load and bedload contribute to the matrix material infilling gravel frameworks. A selective depositional process, controlled by the pore-size distribution of the framework gravels, dictates the actual grain-size distribution of the matrix for a given suspended sediment size-range. The results of this investigation taken together with those of previous studies suggest that artificial spawning gravels should not be well graded. Rather, more poorly graded sediments with the size range truncated at 2 mm would be preferable to prevent excessive quantities of silt entering the void space. The exact size distribution of such a mix cannot be known precisely as the optimum distribution will vary depending upon the size characteristics of the natural sediment load. Despite considerable scatter in the data, spatial patterns in both matrix deposition from suspension and from bedload are evident. The pattern is more smoothed in the case of the finer suspended load compared with the bedload. Bed topography is very important in controlling the pattern of velocity and hence the sediment supply-rate and therefore the potential deposition. Nevertheless zones of low velocities may also demonstrate high deposition rates where sediment is entrapped in eddies. Deposition rates are an order of magnitude less than rates recorded in lowland streams. Silting although temporally and spatially variable is nevertheless rapid. Trout redds are likely to be fully silted in a matter of a few days under flow regimes subject to small freshnets with an adequate supply of fine sediments. (See also W89-01736) (Lantz-PTT)
W89-01751

SUSPENDED SOLIDS TRANSPORT WITHIN REGULATED RIVERS EXPERIENCING PERIODIC RESERVOIR RELEASES,
Loughborough Univ. of Technology (England). Dept. of Geography.
D. J. Gilvear.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 245-255, 8 fig, 23 ref.

Descriptors: *Rivers, *Regulated flow, *Reservoirs, *Suspended solids, *Sediment transport, Wales, Afon Trywern, Washburn River, Turbidity, Reservoirs.

Using a controlled reservoir release from Llyn Celyn to the regulated Afon Trywern, Wales, as a case study, this paper illustrates turbidity and suspended solids changes both at-a-site and downstream. In addition, data collected during 24 other reservoir releases are used to examine the factors determining suspended solids loads. Eleven of these were also on the Afon Trywern, ten on the River Washburn, with one release on each of the rivers North Tyne, Garry and Sutton Brook. Removal of within-channel accumulations of material during reservoir releases results in variations of both turbidity and suspended solids. With greater loads, suspended solids concentrations and the duration of elevated concentrations are increased. Turbidity is also increased, although this relates not only to the concentrations of suspended solids but to the nature of material is suspension. The data demonstrate the potential of reservoir releases to remove fine superficial coverings of material that accumulate during the low flows. Substratum disturbance is needed to remove material once it has infiltrated the channel bed. The loads transported and the suspended solids concentrations can be related to the time since the last release. Thus, if maximum levels of these parameters are defined, optimum time intervals can be quantified. Maintaining turbidity below critical levels is more problematic in that it varies with the nature of material being transported. The results presented here suggest that levels will be highest when fine minerogenic matter dominate the seston. (See also W89-01736) (Lantz-PTT)
W89-01752

EFFECTS OF SHORT-TERM REGULATION BY POWER PLANTS ON EROSION AND WATER QUALITY OF A RIVER,
Valtion Teknillinen Tutkimuskeskus, Espoo (Finland).
For primary bibliographic entry see Field 6G.
W89-01755

WATER EROSION IN THE DRYLAND CROPPING REGIONS OF AUSTRALIA. 4. LAND AND LAND USE DATA FOR A RELATIVE ASSESSMENT OF POTENTIAL SOIL MOVEMENT IN VICTORIA,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
G. A. Yapp, and F. R. Gibbons.
CSIRO Technical Memorandum 88/7, June 1988. 116p, 1 fig, 2 tab, 12 ref.

Descriptors: *Erosion, *Dry farming, *Australia, *Land use, *Soil erosion, Farming, Soil loss, Data collections, Maps.

The dryland cropping region of Victoria is divided into 19 Districts in 5 Sub-Regions. Each includes from one to nine Local Government Areas (LGAs) according to size and comparative similar-

ity of environment and land use. Estimates are given for the proportion of each LGA in slope classes that are relevant to conservation oriented crop management practices. The principal cropping soils are allocated to these slope classes and the area cropped in a base period (1983-84) is allocated to these soils. The logic of the Universal Soil Loss Equation (USLE) is used to estimate the potential movement of soil from the area cropped in each soil x soil class in the standard period. (Author's abstract)
W89-01804

RED RIVER WATERWAY SEDIMENTATION STUDY DOWNSTREAM FROM LOCK AND DAM NO. 1: NUMERICAL MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
R. R. Copeland, and W. A. Thomas.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report HL-88-15, June 1988. Final Report. 65 p, 22 fig, 6 tab, 24 plates, 11 ref.

Descriptors: *Red River, *Sedimentation, *Mathematical models, *Locks, *Dams, *Navigation, Model studies, Gates, Deposition, Sediment control, HEC-2 Model, TABS-2 Model, Computer models, Louisiana.

The effect of recently constructed and proposed channel improvements on sedimentation in the Red River (Louisiana) downstream from Lock and Dam No. 1 were investigated. A one-dimensional numerical model (HEC-6) was used to evaluate the effect of contraction works on dredging requirements in the navigation channel. A two-dimensional numerical model (TABS-2) was used to evaluate proposals to reduce deposition in the downstream lock approach channel at Lock and Dam No. 1. Deposition against the downstream lock miter gate can be reduced by raising the I-wall above the water level. Deposition at the gate will decrease as the distance between the end of the raised I-wall and the lock gate increases. (Lantz-PTT)
W89-01814

HANDBOOK OF NONPOINT POLLUTION: SOURCES AND MANAGEMENT,
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-01822

ATCHAFALAYA RIVER DELTA. REPORT 2: FIELD DATA, SECTION 1: ATCHAFALAYA BAY PROGRAM DESCRIPTION AND DATA, VOLUME I: MAIN TEXT,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2L.
W89-01825

2K. Chemical Processes

MODEL FOR INFILTRATION IN FROZEN SOILS THAT ACCOUNTS FOR WATER QUALITY (UN MODELE POUR L'INFILTRATION DANS LES SOLS GELES TENANT COMPTE DE LA QUALITE DE L'EAU),
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec). Centre de l'Energie.
For primary bibliographic entry see Field 2G.
W89-01339

LOSS OF HALIDE AND SULPHATE IONS FROM MELTING ICE,
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-01447

INFLUENCE OF PARTITION COEFFICIENT OF LIPOPHILIC COMPOUNDS ON BIOCONCENTRATION KINETICS WITH FISH,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
For primary bibliographic entry see Field 5B.
W89-01448

ARSENIC SPECIATION AND QUALITY OF GROUNDWATER IN A LEAD-ZINC MINE, IDAHO,
Idaho Univ., Moscow. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-01456

SYNGENETIC ORIGIN OF GYPSUM CRYSTALS BEARING BACTERIAL CALCITE NEOFORMATION, DISCOVERED WITHIN SUSPENDED MATTER IN THE LOIRE RIVER ESTUARY,
Nantes Univ. (France). Lab. de Geologie Marine.
For primary bibliographic entry see Field 2L.
W89-01512

EFFECTS OF DISSOLVED OXYGEN ON THE BIODEGRADATION OF BTX IN A SANDY AQUIFER,
Shell Development Co., Houston, TX.
For primary bibliographic entry see Field 5B.
W89-01557

PENTACHLOROPHENOL ADSORPTION ON SOILS AND ITS POTENTIAL FOR MIGRATION INTO GROUND WATER,
Missouri Univ., Columbia. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-01642

SORPTION KINETICS OF COMPETING ORGANIC SUBSTANCES ON NEW JERSEY COASTAL PLAIN AQUIFER SOLIDS,
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
For primary bibliographic entry see Field 5B.
W89-01643

CHARACTERIZATION OF BASELINE PRECIPITATION AND STREAM CHEMISTRY AND NUTRIENT BUDGETS FOR CONTROL WATERSHEDS,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
W. T. Swank, and J. B. Waide.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 57-79, 9 fig, 12 tab.

Descriptors: *Precipitation, *Streams, *Chemistry of precipitation, *Water chemistry, *Forest hydrology, *Acid rain, Sulfates, Hydrogen ion concentration, Sulfuric acid, Water pollution sources, Chemical analysis, Nitric acid, Annual distribution, Chlorine, Sodium, Calcium, Seasonal variation, Potassium, Magnesium.

Analysis of an eight-gage bulk precipitation network distributed over the Coweeta Basin shows that weekly arithmetic averages of ion concentrations across all gages provide a reasonable means of estimating bulk solute inputs to individual watersheds. Weekly grab samples of stream water appear to be sufficiently frequent to provide adequate estimates of solute export of all ions except SO4, which is underestimated by grab sample methods. The chemical composition of bulk precipitation is dominated by H and SO4 ions and is characterized as a dilute solution of sulfuric and nitric acids buffered by base cations to produce a mean annual pH of 4.6. Composition of stream water representative of low-elevation watersheds shows that Na and HCO3 are the dominant ions and that stream water is characterized as a cation-bicarbonate solution with a mean pH of 6.7. Dryfall can be a major source of chemical loading at Coweeta for some ions and exhibits substantial year-to-year variability. Annual sulfate dryfall inputs have decreased about 50% over a 9-year period; a slight tendency for a decline in Ca inputs over time is also apparent. Sea salt aerosols are the major sources of Cl and Na and about 40% of Mg in bulk precipitation. Remaining ions are almost entirely of terrestrial origin. Analysis of long-term trends of mean annual precipitation and stream chemistry showed no significant trends of increasing or decreasing acidity, although annual stream water H ion concentrations were partially related to precipitation H ion concentrations. When all ions in both precipitation and stream water were examined, the most definitive annual trend was an increase in stream waters SO4 concentrations. This trend was present for all control watersheds, with an average increase of about 0.7 microequivalents/L/yr. The only significant trend in precipitation chemistry was a decline in concentrations of Ca and the four cations summed. (See also W89-01691) (Lantz-PTT)
W89-01695

STREAM CHEMISTRY RESPONSES TO DISTURBANCE,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
For primary bibliographic entry see Field 4C.
W89-01709

LEACHABILITY OF SOLIDIFIED (BA, RA)SO4 SEDIMENTS IN SIMULATED SETTLING PONDS,
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
For primary bibliographic entry see Field 5B.
W89-02013

2L. Estuaries

INVESTIGATIONS OF THE BENTHOS OF MANGROVE COASTAL LAGOONS IN SOUTHERN CUBA,
Universidad de la Habana (Cuba). Centro de Investigaciones Marinas.
R. Lalana-Rueda, and F. Gosselck.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 6, p 779-794, 1986. 9 rig, 45 ref.

Descriptors: *Invertebrates, *Cuba, *Lagoons, *Mangrove forests, *Benthos, Benthic flora, Benthic fauna, Biomass, Nematodes, Copepods, Polychaetes, Oligochaetes, Ostracods, Amphipods, Mollusks, Tanaidaces, Tolete lagoon, Basto lagoon, Species composition.

Benthic studies were undertaken in two mangrove-lagoons on the south coast of Cuba. Both lagoons are approximately 30-50 cm deep and the tidal range is 15-20 cm. There is little influx of fresh water, and the lagoons are normally euhaline. Most of the lagoon bottom is not colonized by plants, although filamentous algae (Cladophora and Enteromorpha spp.) and Thalassia testudinum grow in a few places. Meiobenthic organisms account for 92% of the invertebrates in the benthic zone of the lagoon. The five most common taxa (Nematoda, Copepoda, Tanaidacea, Oligochaeta, Polychaeta) account for 88-94% of the total number of individuals in Tolete Lagoon and in Basto Lagoon the five most common taxa (Nematoda, Copepoda, Ostracoda, Amphipoda, Polychaeta) account for 97-98%. Biomasses were 26.6 g/sq m in Tolete and 20.2 g/sq m in Basto Lagoon. The dominant taxon on the roots of Rhizophora mangle is Crustacea (Balanus eburneus, B. recurvus and Corophium insidiosum), accounting for over 60% of the total number of individuals. They are followed by mollusks (Crassostrea rhizophora) and the polychaetes (serpulids). (Author's abstract)
W89-01281

RECOMMENDATIONS FOR THE DETERMINATION OF PH IN SEA WATER AND ESTUARINE WATERS,
Newcastle upon Tyne Univ. (England). Dept. of Physical Chemistry.
For primary bibliographic entry see Field 7B.
W89-01295

INFLUENCE OF TROPICAL ENVIRONMENT CONDITIONS ON THE MORPHOLOGY AND CHEMICAL COMPOSITION OF THE TEST OF FORAMINIFERA (GEN. AMMONIA) (INFLUENCE DES ENVIRONNEMENTS INTERTROPICAUX SUR LA MORPHOLOGIE ET LA COMPOSITION GEOCHIMIQUE DE TESTS DE FORAMINIFERES (GENRE AMMONIA) DU SENEGAL),
Perpignan Univ. (France). Lab. of Marine Sedimentology and Geochemistry.
J. Ausseil-Badie.
Comptes Rendus de l'Academie des Sciences (Series 3) CHDDAT, Vol. 306, p 565-568, May 21, 1988. 14 ref. English summary.

Descriptors: *Foraminifera, *Estuarine environment, *Chemical composition, *Morphology, *Tropical regions, Senegal, Protozoa, Physical properties, Chemical properties, Geochemistry, Magnesium, Heavy metals, Strontium, Calcite, Diagenesis, Environment, Marine biology.

Three species of the genus Ammonia (Foraminifera) are studied in relation to the physical and chemical conditions of the water in various estuaries of Senegal. Morphological changes of the test and geochemical variations in the Mg- and Sr-content of the calcite are related to the degree of environmental confinement. The early diagenesis is registered by an Mg-enriched calcite both inside and outside of the tests, while the biogenic calcite content remains identical to the present test calcite. (Author's abstract)
W89-01357

MODEL OF RESIDUAL CURRENTS AND POLLUTANT TRANSPORT IN THE ARABIAN GULF,
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Mathematical Sciences.
For primary bibliographic entry see Field 5B.
W89-01361

MODELLING LONG AND INTERMEDIATE WAVES IN A HARBOR,
Tetra Tech, Inc., Pasadena, CA.
For primary bibliographic entry see Field 8B.
W89-01362

CURRENT STUDIES ON SPECIES INTERACTIONS AND COMMUNITY ECOLOGY OF MACROBENTHOS IN INTERTIDAL FLATS: A REVIEW, (IN JAPANESE),
Nagasaki Univ. (Japan). Faculty of Fisheries.
A. Tamaki.
Japanese Journal of Ecology JJECDN, Vol. 36, No. 1, p 55-68, 1986. 2 fig, 2 tab, 82 ref. English summary.

Descriptors: *Benthic fauna, *Intertidal areas, *Aquatic populations, *Macroinvertebrates, *Ecosystems, Predation, Literature review, Population density, Case studies.

A review is presented for experimental approaches to species interactions in macrobenthos inhabiting intertidal flats and to the effects of predators on their abundance pattern. Species interactions such as reduced competition through partition of resources, inhibition of larval recruitment by established adults, strong competition between adults, and promotive effects on small-sized organisms by large-sized bioturbating infauna are discussed. In the organization process of an intertidal flat community, the importance of predation pressure lowering the density of macrobenthos below the carrying capacity of their habitat and that of adult-larval interactions and bioturbation of sediment are highlighted, based on the results of two case studies. (Author's abstract)
W89-01381

COMBINED TOXICITY OF COPPER, CADMIUM, ZINC, LEAD, NICKEL, AND CHROME TO THE COPEPOD TISBE HOLOTHURIAE,
Athens Univ. (Greece). Zoological Lab. and Museum.
For primary bibliographic entry see Field 5C.
W89-01394

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART III,
For primary bibliographic entry see Field 2E.
W89-01414

FINITE ELEMENT CHARACTERISTIC ADVECTION MODEL,
Rosenstiel School of Marine and Atmospheric Science, Miami, FL. Div. of Applied Marine Physics.
For primary bibliographic entry see Field 5B.
W89-01418

MODELING TURBULENT TRANSPORT IN STRATIFIED ESTUARY,
Hanover Univ. (Germany, F.R.). Inst. fuer Stroemungsmaschinen.
For primary bibliographic entry see Field 5B.
W89-01419

DETERMINATION OF FORMATE IN NATURAL WATERS BY A COUPLED ENZYMATIC/HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC TECHNIQUE,
Rosenstiel School of Marine and Atmospheric Science, Miami, FL. Div. of Marine and Atmospheric Science.
For primary bibliographic entry see Field 2H.
W89-01421

SEDIMENT-WATER OXYGEN AND NUTRIENT FLUXES IN A RIVER-DOMINATED ESTUARY,
Louisiana State Univ., Baton Rouge. Coastal Ecology Lab.
K. G. Teague, C. J. Madden, and J. W. Day.
Estuaries ESTUDO, Vol. 11, No. 1, p 1-9, March 1988. 7 fig, 1 tab, 40 ref.

Descriptors: *Estuaries, *Rivers, *Sediments, *Nutrients, *Dissolved oxygen, *Nutrient flux, Oxygen, Nitrogen, Phosphorus, Ammonium, Seasonal variation, Bays, Chemical properties.

Sediment oxygen uptake and net sediment-water fluxes of dissolved inorganic and organic nitrogen and phosphorus were measured at two sites in Fourleague Bay, Louisiana, from August 1981 through May 1982. This estuary is an extension of Atchafalaya Bay which receives high discharge and nutrient loading from the Atchafalaya River. Sediment O2 uptake averaged 49 mg/sq m/h. On average, NH4(+) was released from the sediments, and NO3(-) was taken up. However, very different NO3(-) fluxes were observed at the two sites, with sediment uptake at the upper, river-influenced, high NO3(-) site and release at the lower, marine-influenced, low NO3(-) site. PO4(---) fluxes were low and often negative, while dissolved organic phosphorus fluxes were high and positive. Dissolved organic nitrogen fluxes varied greatly, ranging from a mean of +305 micromol/sq m/h at the lower bay, to -710 micromol/sq m/h at the upper bay. Total dissolved nitrogen and phosphorus fluxes indicated the sediments were a nitrogen and phosphorus source at the lower bay, and a nitrogen sink and phosphorus source in the upper bay. Mean annual O:N ratios of the positive inorganic sediment fluxes were 27:1 at the upper bay and 18:1 at the lower bay. Based on these data it is hypothesized that nitrification and denitrification were important sediment processes in the upper bay. Atchafalya River probably affected sediment-water fluxes through seasonally high nutrient loading which lead to net nutrient uptake by sediments in the upper bay and released in the lower bay, where there was less river influence. (Author's abstract)
W89-01422

ESTIMATING THE NET FLUX OF NUTRIENTS BETWEEN A SALT MARSH AND A TIDAL CREEK,
South Carolina Univ., Columbia. Dept. of Statistics.
J. D. Spurrier, and B. Kjerfve.
Estuaries ESTUDO, Vol. 11, No. 1, p 10-14, March 1988. 2 fig, 2 tab, 9 ref. NSF Grant DEB 811952.

Descriptors: *Nutrient flux, *Marshes, *Streams, *Nutrients, Salt marshes, Tides, Statistical analysis, Regression analysis, Mathematical models.

Statistical aspects of estimating net fluxes of nutrients between a salt marsh and a tidal creek on a tidal cycle basis and an annual basis are explored. For individual tidal cycles, the instantaneous flux of a nutrient is written in a constrained linear model as a function of time. The model is rewritten as an unconstrained model, and net flux is shown to be a linear combination of the parameters of the model. Standard linear models techniques can be used to make inferences about net fluxes on a tidal cycle basis. Considering a year as a finite population of tidal cycles, annual net flux can be estimated using a regression estimator. In the case of the flux of dissolved nitrite plus nitrate, the marsh was found to be a statistically significant sink for nitrogen (in this form) from adjacent tidal creeks. (Author's abstract)
W89-01423

SEASONAL AND SPATIAL VARIABILITY IN MACROBENTHOS COMMUNITIES IN JAMAICA BAY, NEW YORK: AN URBAN ESTUARY,
Brooklyn Coll., NY. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W89-01424

MACROBENTHIC COMMUNITIES FROM WETLAND IMPOUNDMENTS AND ADJACENT OPEN MARSH HABITATS IN SOUTH CAROLINA,
Marine Resources Research Inst., Charleston, SC.
E. L. Wenner, and H. R. Beatty.
Estuaries ESTUDO Vol. 11, No. 1, p 29-44, March 1988. 7 fig, 4 tab, 51 ref. Department of Commerce Grant NA81AA-D-00093, NA83AA-D-00057, NA84AA-D-00058, and NA85AA-D-SG121.

Descriptors: *Salt marshes, *Benthos, *Rice cultivation, *Reservoirs, Macroinvertebrates, Macrophytes, Spatial distribution, Species diversity, Population density, Habitats, Wetlands, Streams, Statistical analysis.

Forty-eight core and grab samples were taken from two impoundments and an adjacent tidal creek and salt marsh during each of six sampling periods (January, June and November 1983; and January, April and July 1984). Habitats sampled within the impoundments included the perimeter ditch and shallow vegetated areas dominated by Ruppia maritima, Spartina alterniflora, and Scirpus robustus. The adjacent tidal creek bottom and low marsh of S. alterniflora were sampled for comparison with the impoundment sites. Major differences in faunal composition and density of macrobenthic invertebrates were observed between habitats in this study. Macrobenthic density was highest (475 individuals 0.05/ sq m) at the impoundment site dominated by Scirpus robustus, where oligochaetes were abundant. The open marsh site had a density of 254 individuals 0.05/sq m. Among unvegetated sites, density for all sampling periods was higher in Chainey Creek than in the perimeter ditches of the impoundments. The total number of taxa was highest for the open marsh and tidal creek sites. The impoundments contained vegetated sites which were inhabited by fewer species than nonimpounded sites, while the perimeter ditch sites were comparatively depauperate. Cluster and nodal analyses identified four broad assemblages based on habitat: (1) an open marsh assemblage; (2) a creek assemblage; (3) a eurytopic assemblage; and (4) an impoundment assemblage. The separation of faunal assemblages by sampling site rather than sampling period suggests that physical differences between habitats were important factors determining distribution patterns. (Author's abstract)
W89-01425

FOOD HABITS AND DISTRIBUTION OF WINTERING CANVASBACKS, AYTHYA VALISINERIA, ON CHESAPEAKE BAY,
Patuxent Wildlife Research Center, Laurel, MD.
M. C. Perry, and F. M. Uhler.
Estuaries ESTUDO, Vol. 11, No. 1, p 57-67, March 1988. 5 fig, 9 tab, 31 ref.

Descriptors: *Estuaries, *Water milfoild, *Waterfowl, *Food habits, *Wetlands Ducks, Population dynamics, Habitats, Spatial distribution, Macroinvertebrates, Clams, Macrophytes, Seasonal variation, Regression analysis, Chesapeake Bay.

Baltic clams (Macoma balthica) were the predominant food items of 323 canvasbacks (Aythya valisineria) collected throughout Chesapeake Bay during 1970-1979. Natural vegetation constituted 4% of the food volume. Widgeongrass (Ruppia maritima) and redhead grass (Potamogeton perfoliatus) constituted the greatest percent volume and frequency of occurrence among the plant species, whereas wild celery (Vallisneria americana) constituted only a trace of the food volume. These results contrast with historical records of food habits of canvasbacks in Chesapeake Bay. Canvasback population estimates during the 1970's were examined to detect annual and seasonal changes in distribution. Linear regression analyses of winter canvasback populations in the bay showed a significant decline in the upper-bay and middle-bay populations, but no significant changes in the lower-bay and Potomac River populations. The changes in winter distribution and abundance of the canvasback appear related to changes in natural food availability, which is the result of altered environmental conditions e.g., a decline in aquatic vegetation due to increased turbidity and herbicides. (Author's abstract)
W89-01426

STUDY ON POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS IN RIVERS AND ESTUARIES IN OSAKA BAY IN JAPAN.
Setsunan Univ., Neyagawa (Japan). Faculty of Pharamaceutical Sciences.
For primary bibliographic entry see Field 5B.
W89-01440

EFFECTS ON SALTWATER ORGANISMS,
California State Univ., Long Beach. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W89-01503

SYNGENETIC ORIGIN OF GYPSUM CRYSTALS BEARING BACTERIAL CALCITE NEOFORMATION, DISCOVERED WITHIN SUSPENDED MATTER IN THE LOIRE RIVER ESTUARY,
Nantes Univ. (France). Lab. de Geologie Marine.
F. Ottmann, and W. R. Shi.
Comptes Rendus de l'Academia des Sciences (Series 2) CHDCAQ, Vol. 306, No. 12, p 803-808, March 28, 1988. 6 fig, 11 ref.

Descriptors: *Estuaries, *Microbial degradation, *Sediments, *Bacteria, *Gypsum, Clay formation, Loire River, France, Sulfieds, Calcium carbonate.

Gypsum crystals found among the suspended matter in the Loire Estuary originate from the bacterial oxidation of the mud's sulfides. They have syngenetic origin. These crystals were subjected to a further alteration with neo-genesis of the calcium carbonate microcrystals, also due to bacterial action. This phenomenon cound be attributed to the severe drought that has parched the muds on the Loire's banks. (Author's abstract)
W89-01512

INTERNATIONAL ENVIRONMENTAL LAW AND POLICY: AN OVERVIEW OF TRANSBOUNDARY POLLUTION,
Illinois Univ. at Chicago Circle.
For primary bibliographic entry see Field 6E.
W89-01514

RELATIONSHIPS OF PHYTOPLANKTON WITH CERTAIN ENVIRONMENTAL FACTORS IN THE SOUTH EUBOIKOS GULF (GREECE),
Institute of Oceanographic and Fisheries Research, Athens (Greece).
N. Friligos, and O. Gotsis-Skretas.
PSZNI: Marine Ecology, Vol. 8, No. 1, p 59-73, 1987. 4 fig, 5 tab, 34 ref.

Descriptors: *Eutrophic waters, *Phytoplankton, *Gulfs, *Euboikos Gulf, *Mediterranean Sea, Environmental effects, Nutrients, Species diversity, Chlorophyll a, Diatoms, Algae, Salinity, Zooplankton, Eutrophication, Seas.

The abundance and taxonomic diversity of phytoplankton was studied in relation to certain environmental factors in the South Euboikos Gulf, a restricted tidal embayment on the eastern coast of Greece. The northern part of the gulf with higher tidal current and influenced by sewage and industrial effluents, showed high concentrations of nutrients, a greater total density of phytoplankton, relatively high chlorophyll a content, and a lower taxonomic diversity when compared with the southern part. The phytoplankton cycle was largely due to changes in diatom concentration. A slight variation in the occurrence of phytoplankton species and dominance and zooplankton density were observed along the salinity gradients. (Author's abstract)
W89-01520

STRUCTURE OF THE EPIPHYTIC COMMUNITY OF POSIDONIA OCEANICA LEAVES IN A SHALLOW MEADOW,
Stazione Zoologica di Napoli (Italy).
E. Casola, M. Scardi, L. Mazzella, and E. Fresi.
PSZNI: Marine Ecology, Vol. 8, No. 4, p 285-296, 1987. 7 fig, 2 tab, 21 ref.

Descriptors: *Sea grasses, *Wetlands, *Species composition, *Epiphytes, *Microclimates, Hydroids, Bryozoans, Macrophytes, Leaves, Aquatic plants, Ischia Island, Italy, Gulf of Naples, Invertebrates, Succession.

The structure of the epiphytic community (hydroids, bryozoans, and the most abundant macrophytes) of Posidonia oceanica leaves in a shallow meadow near Lacco Ameno, Island of Ischia (Gulf of Naples, Italy) was studied. The structure of the community changed along an age gradient that extended from the inner to the outer leaves and from the basis to the apex of each leaf. This structure was also affected by microclimatic factors. The dynamics of community maturation is described. (Author's abstract)
W89-01522

PHAGE-SENSITIVE BACTERIA IN SEAWATER OF KAGOSHIMA BAY, (IN JAPANESE),
Kagoshima Univ. (Japan). Faculty of Fisheries.
For primary bibliographic entry see Field 5A.
W89-01523

CASE STUDY: BAY OF POZZUOLI (GULF OF NAPLES, ITALY),
ENEA, La Spezia (Italy). Centro Richerche Energia Ambiente.
For primary bibliographic entry see Field 5B.
W89-01732

WETLANDS,
Ohio State Univ., Columbus. School of Natural Resources.
For primary bibliographic entry see Field 2H.
W89-01800

INTERCALIBRATION OF ANALYTICAL ETHODS ON MARINE ENVIRONMENTAL SAMPLES: RESULTS OF MEDPOL II EXERCISE FOR THE INTERCOMPARISON OF TRACE ELEMENT MEASUREMENTS ON MUSSEL TISSUE HOMOGENATE AND MARINE SEDIMENT (MA-M-2/TM AND SD-N-1/2/TM).
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
For primary bibliographic entry see Field 5A.
W89-01813

ATCHAFALAYA RIVER DELTA. REPORT 2: FIELD DATA, SECTION 1: ATCHAFALAYA BAY PROGRAM DESCRIPTION AND DATA, VOLUME I: MAIN TEXT,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
C. J. Coleman, A. M. Teeter, B. P. Donnell, G. M. Fisackerly, and D. A. Crouse.
Available from the National Technical Information Service, Springfield, VA. 22161 as AD-A197 560. Price codes: A03 in paper copy; A01 in microfiche. Technical Report HL-82-15, June 1988. Report 2 of a Series (in Two Volumes). 24p, 9 fig, 1 tab, 3 photos, 6 ref.

Descriptors: *Hydrologic data collections, *Atchafalaya River, *Deltas, *Sedimentation, *Hydrologic studies, Model studies, Louisiana, Estuaries, Salinity, Conductivity, Suspended solids, Water temperature, Water currents.

Data collected for use in development and verification of numerical and physical models employed to predict the evolution of the Atchafalaya Bay Delta are described. Data collection was conducted in this area during 1980 through 1983. Representative results are included covering tidal elevations, current velocity, conductivity, and water temperature, suspended matter, and salinity. Methods used in obtaining these data are described. (Lantz-PTT)
W89-01825

WASTEWATER INPUT TO COASTAL WETLANDS: MANAGEMENT CONCERNS,
San Diego State Univ., CA. Dept. of Biology.
For primary bibliographic entry see Field 5D.
W89-01835

SOME LONG-TERM CONSEQUENCES OF SEWAGE CONTAMINATION IN SALT MARSH ECOSYSTEMS,
Marine Biological Lab., Woods Hole, MA.
For primary bibliographic entry see Field 5C.
W89-01847

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

NALCO WATER HANDBOOK.
For primary bibliographic entry see Field 5F.
W89-01824

3B. Water Yield Improvement

PRECIPITATION DEVELOPMENT IN NATURAL AND SEEDED CUMULUS CLOUDS IN SOUTHERN AFRICA,
Toronto Univ. (Ontario). Dept. of Physics.
D. R. Hudak, and R. List.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 6, p 734-756, June 1988. 12 fig, 9 tab, 30 ref.

Descriptors: *Model studies, *Precipitation, *Cloud liquid water, *Rainfall, *Cloud seeding, *Weather modification, Weather data collections, Southern Africa, Cloud physics, Bethlehem Precipitation Research Project, Cloud models.

The development of precipitation was studied in southern Africa in 23 clouds, 12 unseeded and 11 seeded, from 11 days during the Bethlehem Precipitation Research Project. Surface and upper air data were used to describe the environmental conditions while aircraft and radar data were used to determine the ice water budget in the clouds. Two

relatively simple cloud models were used to help identify seedable situations. They were a one-dimensional steady state model with bulk microphysical parameterization and a one-dimensional time-dependent model with detailed microphysics. The data were divided into three sets based on the main airmasses affecting the area: maritime tropical (mT), continental tropical (cT), and maritime polar (mP). The smaller clouds on the mT days, with tops warmer than -20 C, were the most likely candidates for precipitation enhancement from both the microphysical and dynamic seeding viewpoints. There the time-dependent model calculated a precipitation efficiency increase from 2% to 15% due to seeding. For clouds in the cT air the rapid natural onset of ice suggested that they were not seedable microphysically. Clouds in the mP air were determined to be not seedable because they were either very efficient microphysically or their lifetimes were too short. The developed procedures give insight into the chances for rain enhancement in a given meteorological situation. To treat these results in a statistically significant manner would require a much larger sample of cases. (Author's abstract)
W89-01375

3C. Use Of Water Of Impaired Quality

STRUCTURE OF PERIPHYTIC COMMUNITIES IN *COOLING POND OF NUCLEAR* POWER PLANT,
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
For primary bibliographic entry see Field 2H.
W89-01273

REUSING WATER,
P. Schorr, and R. T. Dewling.
Civil Engineering CEWRA9, Vol, 58, No. 8, p 69-71, August 1988.

Descriptors: *Reclaimed water, *Wastewater renovation, *Domestic water, *Water reuse, Drinking water, Industrial water, Irrigation water, Groundwater recharge.

The worst drought to hit the U.S. in 50 years has underscored the need for conservation, including water reuse. The programs utilized by several states for reclaiming wastewater for agricultural, landscape, domestic and home use are discussed. Dual supply and dual distribution systems are operating successfully. They can be adapted to local conditions and fulfill the objectives of using only the highest quality water for drinking and lower grades of water for groundwater recharge, irrigation, toilet flushing, powerplant cooling and industrial applications. While more information is needed on water reuse in both humid and arid climates, experts have predicted that it may be reasonable to reuse 10-25% of total water consumption in regions of 5-10 million people. (Sand-PTT)
W89-01347

ESTIMATING COSTS MODEL OF DUAL WATER SUPPLY SYSTEMS,
Marsan (Andre) et Associes, Inc., Montreal (Quebec).
For primary bibliographic entry see Field 5F.
W89-01369

HEALTH ASPECTS OF THE USE OF RECYCLED WATER IN WINDHOEK, SWA/NAMIBIA, 1974-1983,
University of the Witwatersrand, Johannesburg (South Africa).
For primary bibliographic entry see Field 5F.
W89-01378

WASTEWATER RECLAMATION AND REUSE,
California State Water Resources Control Board, Sacramento.
T. Asano.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 854-856, June 1988. 46 ref.

Descriptors: *Literature review, *Wastewater renovation, *Wastewater treatment, *Water reuse, Water supply, Management planning, Municipal wastewater, Groundwater recharge, Industrial wastewater, Recycling, Technology.

Literature published in 1987 on water reclamation and reuse is summarized, with emphasis on developments and technologies that contributed more to water supply benefits than to water pollution control. Topics covered are international activities of significance in the wastewater reclamation field, water reuse planning, municipal wastewater reuse, groundwater recharge, industrial water recycling and reuse, and development of technology. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01478

WATER REUSE AND RECYCLING IN INDUSTRY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-02039

IMPLEMENTATION OF AN AQUEOUS WASTE *SUBSTITUTION PROJECT AT GIANT* CEMENT COMPANY AND COMPLIANCE WITH THE ASSOCIATED PERMITS BY *SOUTH CAROLINA DEPARTMENT OF* HEALTH AND ENVIRONMENTAL CONTROL,
South Carolina State Dept. of Health and Environmental Control, Columbia. Div. of Industrial and Agricultural Wastewater.
M. H. Bushway, L. L. Bunn, and R. J. Schoenberger.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 437-446, 2 fig, 4 tab.

Descriptors: *Water pollution control, *Cements, *Water reuse, *Wastewater treatment, Costs, Economic aspects, Air pollution, Volatile organic compounds, Brine, Organic compounds.

Wastewater reuse (substitution) is not a panacea, but for control of polltuion by many types of wastewater it is the best choice available. Pretreatment can aid in making more streams acceptable. Unlike conventional water treatment facilities, the substitution program does not become metal concentration limited. It represents a cost competitive, environmentally sound approach to wastewater disposal. Wastewater substitution was found to have: lower cost than competing technology to the waste generator, lower cement production costs, and increased competition against imports. It is good for the environment because there is: no discharge to waterways or sewers, no discharge onto the land, and the final product integrity requires close and constant checks on the efficiency of the kilns. Emissions to the air are controlled. Metal emissions are only slightly increased even when the water contains very high metal concentrations. Volatile organics are only destroyed between 10% and 40%; therefore, they must be limited or pretreated. Non-volatile organics pyrolyze and, therefore, must be limited for safety and fire. Salt brine has no observed adverse emission concentrations. (See also W89-02006) (Lantz-PTT)
W89-02048

IRRIGATION OF PASTURE WITH MEAT-PROCESSING PLANT EFFLUENT,
Meat Industry Research Inst. of New Zealand, Hamilton.
For primary bibliographic entry see Field 5E.
W89-02055

WATER TREATMENT AND REUSE,
Teesside Polytechnic, Middlesbrough (England). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5F.
W89-02108

3D. Conservation In Domestic and Municipal Use

EFFECTS OF THE DEVELOPMENT OF RURAL WATER SUPPLY ON THE GEOGRAPHIC RHYTHM OF THE VILLAGERS AND AGRICULTURE IN THE MTWARA REGION OF TANZANIA (MAASEUDUN VESIHUOLLON PARANEMISEN VAIKUTUS KYLALAISTEN MAANTIELEELLISEEN RYTMIIN JA MAANVILJELYYN MTWARAN LAANIN ALUEELLA TANSANIASSA),
Helsinki Univ. (Finland). Inst. of Development Studies.
T. Sitari.
Terra, Vol. 98, No. 2, p 168-176, 1986. 7 fig, 12 ref. English summary.

Descriptors: *Water supply development, *Developing countries, *Agriculture, Tanzania, Water distribution.

During the current Decade of Water and Sanitation, the aid agencies have seen the improvement of the water supply as a priority, and it has received a lot of attention from the governments of the developing countries. It can be assumed that the improvement of a water supply has many effects; however, none of them is easy to measure. In this article the effects of the improved water supply in the Mtwara Region of Tanzania are studied in the framework of the daily and annual time-space rhythm of the villagers. The improvement of the water supply reduces the differences in these rhythms between the villages and the climatic seasons. As a consequence of these changes, people in general will have more spare time during the dry season, which eventually will be used for other activities. Since most of the people are farmers, it would be natural to use this time for improving and increasing agriculture, but the climatic conditions set limitations for this unless the farmers can find methods for water control and, this way, extend the cultivating season. (Author's abstract)
W89-01312

3E. Conservation In Industry

WASTE REDUCTION: PROGRAM, PRACTICE AND PRODUCT IN CHEMICAL MANUFACTURING,
Dow Chemical Co., Midland, MI.
For primary bibliographic entry see Field 5G.
W89-01342

SOURCE REDUCTION TECHNICAL ASSISTANCE: A PILOT PROJECT AND ITS IMPLICATIONS FOR THE CHEMICAL INDUSTRY,
Massachusetts Dept. of Environmental Management, Boston.
For primary bibliographic entry see Field 5G.
W89-01343

3F. Conservation In Agriculture

EFFECTS OF THE DEVELOPMENT OF RURAL WATER SUPPLY ON THE GEOGRAPHIC RHYTHM OF THE VILLAGERS AND AGRICULTURE IN THE MTWARA REGION OF TANZANIA (MAASEUDUN VESIHUOLLON PARANEMISEN VAIKUTUS KYLALAISTEN MAANTIELEELLISEEN RYTMIIN JA MAANVILJELYYN MTWARAN LAANIN ALUEELLA TANSANIASSA),
Helsinki Univ. (Finland). Inst. of Development Studies.
For primary bibliographic entry see Field 3D.
W89-01312

CONFLICTS BETWEEN WETLAND CONSERVATION AND GROUNDWATER EXPLOITATION: TWO CASE HISTORIES IN SPAIN,
Universidad Complutense de Madrid (Spain). Dept. of Geodynamics.
For primary bibliographic entry see Field 2H.
W89-01319

GROWING VEGETABLES WITH LITTLE WATER,
Botswana Technology Centre, Gaborone.
I. Martin.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-225611. Price codes: A03 in paper copy, A01 in microfiche. January 1987. 42p.

Descriptors: *Vegetable crops, *Water conservation, *Plant growth, *Drought resistance, Agriculture, Drought, Water shortage, Crops, Cowpeas, Kale, Onions, Spinach, Sweet potatoes, Peppers, Evaporation, Agronomy.

There are many ways to cut down on water use when growing vegetables. This paper recommends using plants and methods which require a minimal input of water, time and money. The plants which require the least care are cowpeas, rape, kale, perennial onions, wild spinach, sweet potatoes and chili peppers. When the plants grow about 5 cm high, then deep rooting can be encouraged by watering them only when they wilt. This saves water because watering is less frequent, so less is lost through evaporation. Further methods of saving water are: planting in basins or furrows which collect rainwater and direct the water to the roots; and using waste water which is not too soapy. One can also purchase shade netting, drip irrigation, and/or rainwater catchment tanks and gutters, if there is enough money and experience. Other essential features of gardening are protecting the plants from wind and animals with good fencing or hedges and keeping away weeds and pests. (Lantz-PTT)
W89-01774

PERSPECTIVE ON SOIL AND WATER CONSERVATION AND AGRICULTURALLY RELATED GROUNDWATER CONTAMINATION,
Soil Conservation Service, East Lansing, MI.
For primary bibliographic entry see Field 4C.
W89-02198

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

BETTER THAN 'OPTIMAL' METHOD FOR DESIGNING DRAINAGE SYSTEMS,
CDM, Raleigh, NC.
S. W. Miles, and J. P. Heaney.
Journal of Water Resources Planning and Management (ASCE) JWPED5, Vol. 114, No. 5, p 477-499, September 1988. 6 fig, 4 tab, 18 ref.

Descriptors: *Drainage systems, *Computer programs, *Storm runoff, *Hydraulic design, *Automation, Computers, Cost analysis, Algorithms, Design criteria, Spreadsheet programs, Florida, Performance evaluation.

The Lotus 1-2-3 spreadsheet package has been used to develop a stormwater drainage design method which is based on the Florida Department of Transportation's (FDOT) hand tabulation form (FDOT 1987). By using the FDOT procedure, the spreadsheet method allows engineers already familiar with the manual calculation procedure to more easily adapt to the new microcomputer environment. The spreadsheet performs the necessary calculations quickly and easily while not hindering the user with tedious input procedures and confusing algorithms typical of many computer codes. The spreadsheet method also employs a heuristic cost estimation approach which allows the user to find a least cost design. This method has been used to solve a problem previously solved with two dynamic programming algorithms. Since the spreadsheet method does not use a sophisticated optimization algorithm, many simplifying assumptions made in the dynamic programming algorithms are not necessary. The results show that the spreadsheet method was able to significantly improve on the dynamic programming designs while more consistently meeting the design criteria. (Author's abstract)
W89-01365

CISTERNS FOR WATER CONSERVATION AND FLOOD CONTROL,
French (R.H.), Las Vegas, NV.
R. H. French.
Journal of Water Resources Planning and Management (ASCE) JWPED5, Vol. 114, No. 5, p 565-577, September 1988. 2 fig, 6 tab, 17 ref.

Descriptors: *Cisterns, *Cost analysis, *Arid regions, *Economic feasibility, Water conservation, Flood-control storage, Storm runoff, Nevada, Comparison studies.

The potential contribution of privately owned cistern systems to both water conservation and flood control in arid and semi-arid regions is examined. Although cistern systems cannot replace all traditional flood control systems, in some cases the use of cistern systems may present an economically attractive technique of conserving water and controlling runoff. For example, the comparison of the annual costs of cisterns and a small detention basin demonstrates that cisterns (given certain assumptions) may offer a competitive alternative if the value of the water lost each year from the detention basin as runoff of evaporation is considered. In the Las Vegas area, the annual cost of water conserved by a cistern ranges from $15 to 17/1,000 gal, while potable water currently costs approximately $1.00/1,000 gal. Given the current cost of water in the American Southwest, cisterns are not yet a viable water conservation alternative. However, in situations in which water conservation and flood control benefits can be combined, cisterns are a cost effective alternative that should be considered. (Author's abstract)
W89-01370

MOUNTAIN CATCHMENT MANAGEMENT WITH GOAL PROGRAMMING,
Department of Environmental Affairs, Pretoria (South Africa).
D. W. van der Zel, and B. H. Walker.
Journal of Environmental Management JEVMAW, Vol. 27, No. 1, p 25-51, July 1988. 6 fig, 4 tab, 22 ref, 5 append.

Descriptors: *Watershed management, *Land use, *Decision making, *Mountain streams, *Management planning, *Alpine regions, Catchment areas, South Africa, Sensitivity analysis.

The problem of resolving conflicts between goals in the management of mountain catchments is considered. The mountain catchments of Southern Africa, as defined here, take up about 12% of the area, but deliver 53% of the mean annual runoff. No clear-cut optimization method has been available to cope with the multiple management goals, so a procedure for land use planning was developed, using goal programming as the appropriate technique. The interaction between four goals in the Natal Midlands mountain catchment is illustrated by optimizing 15 possible land uses on 32 catchment capability classes of land, i.e. where internally homogeneous conditions prevail. The four goals were identified as: (a) delivery of maximum water runoff; (b) delivery of minimum soil loss; (c) provision of maximum outdoor recreation opportunities; and (d) achieving the maximum economic return. A number of scenarios are compared with the present land use situation. To illustrate the technique's versatility, several ordinal solutions are also worked out. The exercise is concluded with a sensitivity analysis of the particular solutions, and in the discussion the features and problems of the goal programming method advocated are treated in detail. It is concluded that the analysis is objective and useful, but that the output is very sensitive to the order of priority of the goals. Avenues of further research are indicated. (Author's abstract)
W89-01374

DISEASE HAZARDS OF IRRIGATION SCHEMES,
Mahidol Univ., Bangkok (Thailand). Faculty of Tropical Medicine.
For primary bibliographic entry see Field 6G.
W89-01379

FATE AND PERSISTENCE OF AQUATIC HERBICIDES,
Minnesota Mining and Mfg. Co., St. Paul. Environmental Lab.
For primary bibliographic entry see Field 5B.
W89-01383

SHEAR WAVES AND UNSTEADY SELECTIVE WITHDRAWAL,
Stanford Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W89-01420

IMPROVEMENTS IN WATERSHED MANAGEMENT YIELD ENHANCED REVENUES,
Washington Suburban Sanitary Commission, Brookeville, MD.
M. J. Grear.
Aqua AQUAAA No.4, p 199-204, 1988. 5 fig, 3 tab, 17 ref.

Descriptors: *Water quality control, *Water pollution control, *Watershed management, *Economic aspects, Reservoir storage, Storage capacity, Public participation, Recreation.

Flexible, innovative solutions for more productive watershed resources management were planned and implemented by the Washington Suburban Sanitary Commission to reduce negative cash flow and to generate additional revenues to help sustain increasingly costly recreational amenities. This was accomplished while continuing to protect raw water quality and preserve reservoir storage capacity. Positive customer goodwill and public relations benefits also accrued because of the sponsored Christmas tree sale. (Hammond-PTT)
W89-01431

PROGRESSIVE ALTERATION OF FINE SEDIMENT ALONG AN URBAN STORM DRAIN,
Exeter Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W89-01457

REGULATED STREAMS: ADVANCES IN ECOLOGY.
For primary bibliographic entry see Field 2H.
W89-01736

CONSIDERATIONS IN ASSESSING FLUSHING FLOW NEEDS IN REGULATED STREAM SYSTEMS,
Bechtel, Inc., San Francisco, CA.
For primary bibliographic entry see Field 2E.
W89-01739

ASSESSMENT OF FLUSHING FLOW RECOMMENDATIONS IN A STEEP, ROUGH, REGULATED TRIBUTARY,
Wyoming Water Research Center, Laramie.
For primary bibliographic entry see Field 2E.
W89-01740

EFFECTS OF VARYING FLOWS IN MANMADE STREAMS ON RAINBOW TROUT (SALMO GAIRDNERI RICHARDSON) FRY,
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
For primary bibliographic entry see Field 2H.

W89-01742

DEVELOPMENT AND APPLICATIONS OF MACROINVERTEBRATE INSTREAM FLOW MODELS FOR REGULATED FLOW MANAGEMENT,
Tulsa Univ., OK. Faculty of Biological Science.
J. A. Gore.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 99-115, 8 fig, 55 ref.

Descriptors: *Macroinvertebrates, *Instream flow, *Model studies, *Flow regulation, *Stream biota, Flow profiles, Fish, Biomass, Ecology.

Instream flow models which have been designed to predict density and biomass changes among benthic macroinvertebrates have been shown to be effective for regulated flow management. Macroinvertebrate flow needs, as they relate to the flow needs of managed fish populations, are particularly important since macroinvertebrates, being less mobile, may have higher discharge requirements under certain flow conditions. Models which have integrated depth, velocity, and substrate values into a single hydraulic index can be used in place of the composite suitability values of the IFG-IV programs and may increase the precision of the flow requirement estimates as well as reducing the variance problems sometimes encountered with the incremental technique. More research is needed to support the general application of macroinvertebrates instream flow studies for regulated flow management. The utility of the model for predicting density and biomass is well documented. It will be the decision of regulatory agencies and stream managers to apply these models and predictions for the maintenance of biotic stability in fluctuating flow environments. (See also W89-01736) (Lantz-PTT)
W89-01743

CLASSIFICATION OF TAILWATER SITES RECEIVING RESIDUAL FLOWS FROM UPLAND RESERVOIRS IN GREAT BRITAIN, USING MACROINVERTEBRATES DATA,
Freshwater Biological Association, Wareham (England). River Lab.
For primary bibliographic entry see Field 6G.
W89-01745

IMPACT OF LARGE DISCHARGE FLUCTUATIONS ON THE MACROINVERTEBRATE POPULATIONS DOWNSTREAM OF A DAM,
Lyon-1 Univ., Villeurbanne (France). Dept. de Biologie Animale et Ecologie.
For primary bibliographic entry see Field 6G.
W89-01746

PREDICTING THE EFFECTS OF A POSSIBLE TEMPERATURE INCREASE DUE TO STREAM REGULATION ON THE EGGS OF WHITEFISH (COREGONUS LAV ARETUS) - A LABORATORY APPROACH,
Oslo Univ. (Norway). Zoological Museum.
For primary bibliographic entry see Field 5C.
W89-01750

SUSPENDED SOLIDS TRANSPORT WITHIN REGULATED RIVERS EXPERIENCING PERIODIC RESERVOIR RELEASES,
Loughborough Univ. of Technology (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W89-01752

TIME-SCALES FOR ECOLOGICAL CHANGE IN REGULATED RIVERS,
Loughborough Univ. of Technology (England). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W89-01753

TOWARDS A RATIONAL ASSESSMENT OF RESIDUAL FLOWS BELOW RESERVOIRS,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W89-01754

EFFECTS OF SHORT-TERM REGULATION BY POWER PLANTS ON EROSION AND WATER QUALITY OF A RIVER,
Valtion Teknillinen Tutkimuskeskus, Espoo (Finland).
For primary bibliographic entry see Field 6G.
W89-01755

POSSIBLE EFFECTS OF THE PROPOSED EASTERN ROUTE DIVERSION OF CHANGJIANG (YANGTZE) RIVER WATER TO THE NORTHERN PROVINCES WITH EMPHASIS ON THE HYDROBIOLOGICAL ENVIRONMENT OF THE MAIN WATER BODIES ALONG THE TRANSFER ROUTE,
Academia Sinica, Lochiaschan (China). Inst. of Hydrobiology.
For primary bibliographic entry see Field 6G.
W89-01761

RESPONSES OF EPILITHIC ALGAE TO REGULATION OF ROCKY MOUNTAIN STREAMS,
Colorado State Univ., Fort Collins. Dept. of Botany and Plant Pathology.
For primary bibliographic entry see Field 6G.
W89-01763

ECOLOGY OF REGULATED STREAMS: PAST ACCOMPLISHMENTS AND DIRECTIONS FOR FUTURE RESEARCH,
Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
For primary bibliographic entry see Field 6G.
W89-01764

AQUATIC NOXIOUS PLANTS LEGISLATION,
Ruakura Soil and Plant Research Station, Hamilton (New Zealand).
For primary bibliographic entry see Field 6E.
W89-01879

FLOW CONTROL,
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
J. R. Irvine, and I. G. Jowett.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 94-112, 2 tab, 76 ref.

Descriptors: *Flow control, *New Zealand, *Dams, *Hydroelectric plants, Environmental protection, Discharge capacity, Sediments, Water temperature, Water quality.

The main objectives of this chapter are to describe physical and biological conditions downstream of New Zealand hydroelectric dams and to discuss practical ways of mitigating harmful downstream effects caused by dams. This chapter brings together results from relevant new Zealand studies, referring to overseas publications primarily when local examples are lacking or inadequate. As effects below dams can be grouped conveniently into those concerning changes in discharge, sediment, water temperature and water quality, the chapter has been organized around these categories. Figures and tables summarize the general effects below dams and lists those hydroelectric developments in New Zealand where environmental considerations have played some role in the establishment of discharge restrictions. (See also W89-01871) (Lantz-PTT)
W89-01880

LAKE LEVEL CONTROL,
Otago Univ., Dunedin (New Zealand). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W89-01881

AQUATIC WEED PROBLEMS,
Ministry of Energy, Hamilton (New Zealand). Electricity Div.
I. M. Johnstone.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 124-137, 3 fig, 1 tab, 40 ref.

Descriptors: *New Zealand, *Aquatic weed control, *Aquatic weeds, Surface water, Weeds, Aquatic plants, Economic aspects, Hydroelectric plants, Screen cleaners, Weed booms, Weeding, Harvesting, Chemical treatment.

Aquatic macrophytes are those plants that live in freshwater habitats and are identifiable (at least to the generic level) with the naked eye. Encompassing angiosperms, ferns, bryophytes and characeans they are a valuable ecological component of freshwater habitats. Under some circumstances, however, aquatic macrophytes can interfere with usage and when this occurs these plants are viewed as weeds. Therefore, the week status of an aquatic macrophyte depends on the function of a lake, and this status in most, if not all, cases will be unrelated to the plant's ecological role. In New Zealand, relatively few macrophyte species interfere with hydroelectric power generation. The paucity of obnoxious species in hydro-lakes is vividly illustrated by reference to Lake Aratiatia, which has a total macrophyte flora of 20 species, of which only three (Lagarosiphon major, Elodea canadensis and Ceratophyllum demersum) cause any significant problems in terms of reservoir function. This chapter briefly reviews how the macrophyte problem in New Zealand hydro lakes originated, the reasons for the problem and possible solutions, which include: screen-cleaners, weed booms, killing the weeds, weeding, weed harvesting, and chemical control. (See also W89-01871) (Lantz-PTT)
W89-01882

ENVIRONMENTAL MANAGEMENT OF WATER PROJECTS,
CRC Press, Inc., Boca Raton, FL. 1987. 158p. Edited by Edward O. Gangstad and Ronald A. Stanley.

Descriptors: *Aquatic weed control, *Aquatic plants, *Environmental policy, *Water resources development, Environmental engineering, Plant control, Ecology, Biological studies, Ecosystems.

Aquatic vegetation occurs naturally in most bodies of water. However, excessive growth of the vegetation is undesirable for environmental engineering management. This volume treats the subject of aquatic plant control by both chemical and nonchemical methods. Detailed data are presented on the ecology and biology of different elements of the ecosystem and the many factors affecting the natural resource environment. The holistic approach to aquatic vegetation control is used to describe and delineate functional relationships as a multidiscipline solution of the problem. (See W89-01991 thru W89-02001) (Lantz-PTT)
W89-01990

CHARACTERISTICS OF SOME LARGE-SCALE RESERVOIRS IN THE U.S. AND CANADA,
For primary bibliographic entry see Field 2H.
W89-01992

BIOLOGICAL PARAMETERS OF THE TVA EURASIAN WATERMILFOIL MANAGEMENT PROGRAM,
Environmental Protection Agency, Washington, DC.
R. A. Stanley, and E. O. Gangstad.
IN: Environmental Management of Water Projects. CRC Press, Inc., Boca Raton, FL. 1987. p 35-47, 3 tab, 14 ref.

Descriptors: *Reservoirs, *Biological studies, *Tennessee Valley Authority, *Eurasian watermilfoil, *Aquatic weed control, Aquatic weeds, Aquatic plants, Butoxyethanal ester, Dichlorophenoxyacetic acid, Herbicides.

Eurasian watermilfoil (Myriophyllum spicatum L.), a submersed aquatic weed, has seriously interfered with many water uses in the Tennessee Valley Authority (TVA) reservoirs. Effective control of this noxious species has been obtained by combining water level manipulation and chemical treatment with granular preparations of the butoxyethanal ester and liquid formulations of the dimethylamine salt of 2,4-dichlorophenoxyacetic acid (2,4-D). The drawdowns permit drying or freezing of stems and rootcrowns throughout the colonized littoral zone while applications of herbicides are made to selected treatment areas. The EPA established tolerances of 0.10 ppm in potable water and 1 ppm in fish flesh for 2,4-D use in the control of Eurasian watermilfoil in TVA reservoirs. (See also W89-01990) (Lantz-PTT)
W89-01993

BIOLOGICAL PARAMETERS INFLUENCING GROWTH AND REPRODUCTION OF HYDRILLA,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 2E.
W89-01995

TECHNICAL REVIEW OF THE FACTORS AFFECTING 2,4-D FOR AQUATIC USE,
E. O. Gangstad.
IN: Environmental Management of Water Projects. CRC Press, Inc., Boca Raton, FL. 1987. p 73-84, 61 ref.

Descriptors: *Aquatic weed control, *Dichlorophenoxyacetic acid, *Herbicides, *Fate of pollutants, Water pollution effects, Environmental effects, Crops, Chemical treatment.

The herbicide 2,4-D was prepared in 1941 by the interaction of 2,4-dichlorophenol, monochoroacetic acid, and sodium hydroxide, and a similar process is used in its commercial production. It is used to control aquatic weeds in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, canals, rivers, and streams that are quiescent or slow moving. It is one of a family of phenoxy herbicides that are predominantly toxic to green plants and much less toxic to mammals, birds, fish, reptiles, shellfish, insects, worms, fungi, and bacteria. When properly used, it does not persist in the environment at levels harmful to animals and aquatic organisms. It does not concentrate in food chains and is detectable only rarely in food and then in only insignificant amounts. The principal hazard in the use of the phenoxys is to crops and other valuable plants either within the treated are or nearby. Treated crops can be injured through accidental overdosing, improper timing of treatments, unusual weather conditions, and other causes. Injury to nearby crops and ornamentals can result from drift of droplets or vapors of the spray. Such losses are largely preventable through the use of proper formulations and spray equipment and the exercise of good judgement. (See also W89-01990) (Author's abstract)
W89-01996

TECHNICAL REVIEW OF THE FACTORS AFFECTING ENDOTHALL FOR AQUATIC USE,
E. O. Gangstad.
IN: Environmental Management of Water Projects. CRC Press, Inc., Boca Raton, FL. 1987. p 85-94, 31 ref.

Descriptors: *Aquatic weed control, *Endothall, *Fate of pollutants, *Herbicides, Biodegradation, Aquatic weeds, Oxygen, Fish mortality, Chemical treatment.

Endothall (7-oxabicyclo (2.2.1)heptane-2,3-dicarboxylic acid) is related to cantharidic acid, a chemical found in nature, and unlike almost all other herbicides, contains only carbon, hydrogen, and oxygen. It was discovered as having herbicidal properties in 1950 as a dessicant for terrestrial plants. The aquatic herbicidal properties were discovered in 1953, and it was first registered for this purpose in 1960. Endothall (Aquathol K) is a moderately selective contact herbicide. It is rapidly degraded by microorganisms in the soil which utilize the degraded fragments of the chemical in their own metabolic systems. The typical half-life of the herbicide in treated water is 2 to 3 days. Decomposition of heavy infestations of weeds controlled by endothall may reduce oxygen levels in static water and this could cause suffocation of some fish in these areas. As the label direct, water containing heavy vegetation should be treated in sections at 5- to 7-day intervals to prevent suffocation of fish. As a consequence of the rapid degradation, there is no tendency of the chemical to bioaccumulate in aquatic organisms. (See also W89-01990) (Lantz-PTT)
W89-01997

TECHNICAL REVIEW OF FACTORS AFFECTING DIQUAT FOR AQUATIC USE,
Environmental Protection Agency, Washington, DC.
R. A. Stanley, and E. O. Gangstad.
IN: Environmental Management of Water Projects. CRC Press, Inc., Boca Raton, FL. 1987. p 95-107, 53 ref.

Descriptors: *Aquatic weed control, *Diquat, *Herbicides, *Fate of pollutants, Diquat dibromide, Diquat dichloride, Alkalinity, Soil contamination, Chemical reactions, Chemical treatment, Water pollution, Aquatic weeds.

Diquat is a quaternary salt of 4,4'-dipyridyl formulated as the dichloride or dibromide salts. Since the discovery of its herbicidal properties in the late 1950s, diquat has been used widely for the control of a broad spectrum of aquatic vegetation. Diquat compounds used as herbicides are diquat dibromide and diquat dichloride. Diquat dibromide is very soluble in water, slightly soluble in alcoholic and hydroxylic solvents, and practically insoluble in nonpolar organic solvents. It is essentially lipid insoluble and is stable in acid or neutral solutions and unstable under alkaline conditions. Commercial diquat formulations contain a corrosion inhibitor and a buffer. Diquat is adsorbed on soils by exchange reactions up to the cation exchange capacity of the soil, and the adsorption is essentially irreversible in montmorillonitic clays, but partially reversible in kaolinitic clays. Apparently, only a small portion of applied diquat is absorbed by aquatic weeds, and little translocation of diquat occurs. Ultraviolet light rapidly degrades diquat in aqueous solution. Diquat resists biological degradation in aquatic environments, but the presence of sorbents in the water in the form of particulate matter greatly influences diquat persistence in the aquatic environment. (See also W89-01990) (Lantz-PTT)
W89-01998

TECHNICAL REVIEW OF THE FACTORS AFFECTING AQUATIC USE OF DICHLOBENIL,
E. O. Gangstad.
IN: Environmental Management of Water Projects. CRC Press, Inc., Boca Raton, FL. 1987. p 117-122, 24 ref.

Descriptors: *Aquatic weed control, *Dichlobenil, *Herbicides, *Environmental effects, Fate of pollutants, Aquatic weeds, Plant growth, Toxicity, Lethal limits, Bluegill, Sunfish, Bass, Elodea, Watermilfoil, Naiad, Coontail, Chara, Pondweeds, Alligatorweed.

Dichlobenil is the common name for 2,6-dichlorobenzonitrile. It is used as a herbicide for controlling aquatic plants in lakes, ponds, ditches, and to some extent in flowing water. The herbicidal activity of dichlobenil is characterized by a powerful inhibition of plant growth. The herbicide is not acutely toxic to fish at concentrations generally used for weed control. The range of LD sub 50 is 10 to 20 ppm for pumpkin seed (Lepomis gibbosus), bluegill (L. macrochirus), redear sunfish (L. microlophus), and largemouth bass (Micopteris salmoides). There are no known adverse effects on wildlife mammals at the rates used for weed control. Dichlobenil should not be used if the air temperature is expected to go above 70 F within a week. It is long lasting at low and moderate temperatures, and seeding or transplanting in treated soil should be delayed for 24 months after treatment. Dichlobenil (Casoron G-10) granules should be applied at a rate 7 to 10 lb ai(70 to 100 lb G-10)/surface A in the early spring before weeds start growing. Weeds controlled are Elodea, northern watermilfoil, naiad, Chara, pondweeds (Potamogeton spp.), and alligatorweed (Alternanthera philoxeroides). (See also W89-01990) (Lantz-PTT)
W89-02000

STRATEGIES FOR AQUATIC VEGETATION MANAGEMENT,
Environmental Protection Agency, Washington, DC.
R. A. Stanley, and E. O. Gangstad.
IN: Environmental Management of Water Projects. CRC Press, Inc., Boca Raton, FL. 1987. p 125-140, 201 ref.

Descriptors: *Aquatic weed control, *Vegetation, *Aquatic plants, Chemical treatment, Vascular plants, Plant growth, Nitrates, Biological studies, Physical studies.

Aquatic vegetation consists of vascular plants which grow emergent in marshes and along shorelines, which float on the surface of water as individual plants or as tangled mats, and which are submersed except in some cases for floating leaves. In general, the fact that these plants are more likely to reproduce asexually rather than sexually is controlled in part by the amount of light and distribution or abundance. Nutrients are less likely to be limiting. Although chemical control is the most practical strategy, biological and physical methods are frequently preferred for the benefits to fish and waterfowl. Then, integrated weed management principles should be used to reduce the 'density'. (See also W89-01990) (Author's abstract)
W89-02001

4B. Groundwater Management

LONG-RANGE PLANNING AND PRIORITY AREAS OF GROUNDWATER MANAGEMENT,
Soil Conservation Service, Centreville, MI.
For primary bibliographic entry see Field 6B.
W89-02222

QUANTIFICATION OF GROUNDWATER RECHARGE IN ARID REGIONS: A PRACTICAL VIEW FOR RESOURCE DEVELOPMENT AND MANAGEMENT,
British Geological Survey, Wallingford (England).
For primary bibliographic entry see Field 2F.
W89-02243

4C. Effects On Water Of Man's Non-Water Activities

NITRATE CONTENT IN FRACTURE ZONE GROUNDWATER IN THE HUMID TROPICS AS RELATED TO DEFORESTATION (LA TENEUR EN NITRATES DES NPPES DE FSSURES DE LA ZONE TROPICALE HUMIDE EN RELATION AVEC LES PROBLEMES DE DEFORESTATION),
Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
J.-P. Faillat, and A. Rambaud.
Comptes Rendus de l'Academie des Sciences (Series 2) CHDCAQ, Vol. 306, No. 15, p 1115-1120, April 21 1988. 4 fig, 16 ref. English summary.

Descriptors: *Groundwater pollution, *Aquifers, *Nitrates, *Forest management, *Deforestation, Tropical regions, Wells, Groundwater.

High nitrate contents (up to 200 mg/l) have been observed in wells drilled in fractured aquifers lying beneath thick layers of weathered and decayed rock, in West Africa where annual rainfall is over 1000 mm and where there is no notable pollution. An attempt was made to find the source of this ion by examining the amounts in various parts of the

region. The first step was statistical processing of all the analyses available (230) using reduced, centered principal-component analysis of bicarbonate, chlorine, nitrate, and sulfate ions. Fifty-six percent of boreholes in the Bongouanou area had nitrate contents of over 0.1 meg per 1, whereas the highest figure in the other areas was 26%. The proportion of villages with nitrate contents of over 0.1 meg per 1 was counted. The fact that these villages were most frequently in the Bongouanou region, the only one to be entirely in a forest area, led to connecting deforestation with the presence of nitrates. When land is cleared for villages and fields, plant wastes, which may subsequently be burned, and humus as well, are amassed. Non-deforested areas are also disturbed by the tracing of footpaths, wood collection, and domestic animals. Although runoff, fixation in the soil, and denitrification make it difficult to measure nitrogen which becomes nitrified or which reaches groundwater in the form of nitrate, it is certain that a significant proportion must reach underground water and contribute to the abnormally-high nitrate levels observed, more common in forest areas, and to their irregular distribution. It is therefore perfectly logical to attribute inflow of nitrogen in groundwater in fractured rock mainly to anthropic deforestation. (Sand-PTT)
W89-01309

ORIGIN AND INFLUENCE OF COAL MINE DRAINAGE ON STREAMS OF THE UNITED STATES,
Geological Survey, Richmond, VA.
For primary bibliographic entry see Field 5B.
W89-01315

CONFLICTS BETWEEN WETLAND CONSERVATION AND GROUNDWATER EXPLOITATION: TWO CASE HISTORIES IN SPAIN,
Universidad Complutense de Madrid (Spain). Dept. of Geodynamics.
For primary bibliographic entry see Field 2H.
W89-01319

USE OF RADIOMETRIC (CS-137, PB-210), GEOMORPHIC, AND STRATIGRAPHIC TECHNIQUES TO DATE RECENT OXBOW SEDIMENTS IN THE RIO PUERCO DRAINAGE GRANTS URANIUM REGION, NEW MEXICO,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Chemistry.
C. J. Popp, J. W. Hawley, D. W. Love, and M. Dehn.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 3, p 253-269, June 1988. 9 fig, 3 tab, 48 ref. Office of Surface Mining, Department of the Interior, Projects G1115352 and G105041.

Descriptors: *Environmental impact, *Sedimentation, *Silting, *Radioactive dating, *Geomorphology, *Stratigraphy, *Uranium mines, Oxbows, Radionuclides, Cesium radioisotopes, Lead radioisotopes, Heavy metals, Grants uranium region, New Mexico, Sediments, Streams.

In the absence of historic geochemical baseline data for the Grants uranium region, environmental changes resulting from uranium mine-mill activities can be determined only by indirect methods. A methodology for determining the age of recent sediments in streams draining the region has been established based on combined geomorphic, stratigraphic, and radiometric dating techniques. Because clay-rich sediments retain possible radionuclides and heavy metals derived from mineralization and mined sources, sample sites which contain fine-grained deposits that both predate and postdate mine-mill activity were located in abandoned-channel segments (oxbows) of major streams draining the eastern Grants uranium region. Aerial photographs (and derivative maps) taken between 1935-71 provided the historical and geomorphic documentation of approximate dates of oxbow formation and ages of alluvial fills in the abandoned-channel segments. Pits were dug at these oxbow sites to determine stratigraphy and composition of the deposits. Samples were subjected to radiometric analysis by gamma ray spectrometry for the artificial radionuclide Cs-137 and the natural radionuclide Pb-210 as well as other U-238 and Th-232 daughters. Because of the dynamic nature of the system, absolute dating with Cs-137 was not possible but samples could be dated as either pre-1950 or post-1950. The 1950 date is important because it marked the beginning of the uranium exploitation in the region. The Pb-210 dating was not possible because background Pb-210 was very high relative to fallout Pb-210. (Author's abstract)
W89-01320

DECLINE IN THE SUSPENDED LOAD OF THE LOWER MISSISSIPPI RIVER AND ITS INFLUENCE ON ADJACENT WETLANDS,
Louisiana State Univ., Baton Rouge. Dept. of Geography and Anthropology.
R. H. Kesel.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 3, p 271-281, June 1988. 11 fig, 6 tab, 23 ref.

Descriptors: *Land use, *Mississippi delta, *Wetlands, *Suspended load, *Sediment discharge, *Levees, *Reservoirs, *Construction programs, Navigation, Deltas, Louisiana, Rivers, Geomorphology.

Since 1850, there has been an overall decrease in excess of 70% in the suspended load transported by the lower Mississippi River. A decrease of 25% between the earliest measurements and 1950 may be partly the result of a decline in discharge and partly the result of a change in land use practices. The largest decrease occurred in 1952-53 following construction of major main-stem reservoirs on the Missouri River. Similar construction on the Arkansas River has resulted in a further decrease in 1962-63. The decrease in suspended load, combined with the artificial levee construction program and the overall enhancement of the river channel for navigation has been accompanied by an accelerating decline in land area of the Louisiana coastal zone from 17 sq km/yr in 1913 to 102 sq km/yr in 1980. (Author's abstract)
W89-01321

EARTHQUAKES, INJECTION WELLS, AND THE PERRY NUCLEAR POWER PLANT, CLEVELAND, OHIO,
Ohio Univ., Athens. Dept. of Geological Sciences.
For primary bibliographic entry see Field 8E.
W89-01335

LESSONS FROM EIA FOR BICOL RIVER DEVELOPMENT IN PHILIPPINES,
Philippines Univ. at Los Banos. Coll. of Engineering and Agro-Industrial Tech.
For primary bibliographic entry see Field 6G.
W89-01367

URBAN GROWTH AND WATER BORNE DISEASES IN IBADAN,
Nigerian Inst. of Social and Economic Research, Ibadan.
For primary bibliographic entry see Field 5B.
W89-01433

URBAN RUNOFF AND COMBINED SEWER OVERFLOW,
Calocerinos and Spina, Liverpool, NY.
For primary bibliographic entry see Field 5B.
W89-01481

RECENT DEVELOPMENTS IN THE LAW OF THE SEA 1986,
For primary bibliographic entry see Field 6E.
W89-01518

SAND RIGHTS: USING CALIFORNIA'S PUBLIC TRUST DOCTRINE TO PROTECT AGAINST COASTAL EROSION,
For primary bibliographic entry see Field 6E.
W89-01519

HISTORY OF COWEETA,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
J. E. Douglass, and M. D. Hoover.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 17-31, 2 fig, append.

Descriptors: *Forest hydrology, *Coweeta, *North Carolina, *Resource development, *Research facilities, *Ecological effects, Research priorities, Forest watersheds, Ecosystems, Agriculture, Water resources development.

To understand the origin and development of 50 years of research at Coweeta, one must understand something of the social, economic, and political circumstances as these changed through time. It was concern about soil erosion, flood control, and sustained flow of streams as well as future timber supplies that led to establishment of the first forest reserves (soon to become national forests) from the public domain lands of the West. The role of the forest in regulating the flow of navigable streams was the constitutional basis for the Weeks Act of 1911. This act allowed the Federal government to purchase private lands for national forest in the East. At the time there was considerable debate about the influence of forests upon regulation of streamflow and flooding. Following the government's purchase of Coweeta in 1931, by June 1936, 19 km of roads and 38 km of trails, 16 stream gages, the hydraulic testing station, a 60-gage network for measuring precipitation, 4 groundwater wells, 3 log cabins, a shop, a nursery, 10 weather stations, and a 1.4 kw powerplant had been built. Manpower from the various relief projects increased from 74 man months in 1934 to 732 in 1935, to almost 2000 in 1936. By 1939, 25 weirs were operating, 18 on unit watersheds up to 140 ha in size and 7 on larger streams containing one or more unit watersheds. Enough records were available by the fall of 1939 to begin tests of the effects of changing watershed cover on three watersheds. During the winter of 1939 to 1940, a 9-ha watershed (WS 3) was cleared to be used for a cornfield and pasture; on a 16-ha watershed (WS 13) all trees were felled but soil was not disturbed in order to determine the amount of water used in transpiration; and a 58-ha watershed (WS 7) was fenced to measure the consequences of grazing cattle in woodlands. Subsequent studies, built upon this early research, further emphasized the effects that man's development of the land, and encroachment on forested acres would have on the overall forest ecosystem. (See also W89-01691) (Lantz-PTT)
W89-01693

CHANGES IN SOIL NITROGEN POOLS AND TRANSFORMATIONS FOLLOWING FOREST CLEARCUTTING,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
J. B. Waide, W. H. Caskey, R. L. Todd, and L. R. Boring.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 221-232, 5 tab.

Descriptors: *Nitrogen, *Soil chemistry, *Clearcutting, *Soil water, *Forest hydrology, Ecological effects, Drainage water, Nutrients, Nitrification, Heterotrophic bacteria, Denitrification.

Together with data on N export in drainage waters and N cycling through vegetation pools, results reported provide an integrated picture of changes in forest N cycling processes on watershed 7 (WS 7) following clear-cutting. Soil organic matter and nitrogen pools increased (20 to 70%) immediately following forest removal. Proportionately larger increases (20 to 50%) in mineral N pools were also observed. These increases in available mineral N may be attributed to slight increases in soil N mineralization (about 25%, or 1 to 3 gm N/sq m/yr), substantial increases in nitrification (about 200%, or 3 to 5 g N/sq m/yr), and reductions in general soil heterotrophic activity and plant N uptake in the first few years after logging. Increases in both symbiotic (1 to 3 g N/sq m/yr) and free-living (1 g/sq m/yr) fixation also added addi-

tional N to soil pools. Only small fractions of these increases in available soil N were exported from WS 7 in drainage waters (ca. 0.1 g n/sq m/yr). Small increases of unknown magnitude in N losses via denitrification also occurred. But, the majority of these increased soil mineral N supplies were retained on site and recycled through rapidly regrowing early successional vegetation pools. Larger fractions of this vegetation uptake of N cycled through labile leaf tissues (rather than being stored in wood) than was the case in control forests. Subsequent increases in soil heterotroph activity, associated with the recovery of the forest canopy and the modernization of harsh soil microenvironments, probably provided a secondary sink of N immobilization, stimulated by large C pools in decaying logging residues. (See also W89-01691) (Lantz-PTT)
W89-01701

EFFECTS OF WATERSHED DISTURBANCE ON STREAM SESTON CHARACTERISTICS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
J. R. Webster, E. F. Benfield, S. W. Golladay, R. F. Kazmierczak, and W. B. Perry.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 279-294, 4 fig, 9 tab.

Descriptors: *Watersheds, *Environmental effects, *Seston, *Streams, *Forest hydrology, Debris, Turbidity, Ecological effects, Organic matter, Long-term effects, Logging.

Watershed disturbances increased seston concentrations in streams at the Coweeta Hydrologic Station in North Carolina. Concentrations of both organic and inorganic materials are increased; however, since the inorganic fraction increases more, the percent ash of seston carried by streams draining disturbed watersheds is higher. In addition, the particles are generally larger and have higher density and fall velocity. Depending on the nature of the disturbance, effects on seston concentration and composition may be seen for 30 to 40 years following disturbance. For commercially logged watersheds, increases in particulate inorganic materials might be explained as the transport of sediment that entered the stream during logging. Seventeen years after disturbance, watershed 6 (WS 6) carries very high concentration os seston. This is correlated with the absence of woody debris in this stream. For more than 40 years, there has been little input of wood to this channel; most old wood has decayed, and there is little to stabilize the stream bed. A similar situation exists on watershed 13 (WS 13), except that some slash was left in the stream during the original clear-cutting and a few of the older logs remain in the channel. Based on the studies conducted at Coweeta, it is assumed that much of the seston in reference streams results from biological processing of allochthonous inputs. Results suggest that more of the seston collected from disturbed watersheds is produced by physical forces. Since samples were taken during baseflow periods, the results probably minimize effects of disturbance. Samples taken during storms would probably show much greater differences. Seston carried by small streams eventually reaches larger streams, and can significantly affect the turbidity and invertebrate community of a larger receiving stream. Seston is also an important food resource for many filter feeding invertebrates. The less organic-rich seston of disturbed streams is probably lower quality food than is the seston from the undisturbed streams. Also, because of its higher density and fall velocity, seston from disturbed streams is probably lower quality food than is the seston from the undisturbed streams. (See also W89-01691) (Lantz-PTT)
W89-01705

STREAMFLOW CHANGES ASSOCIATED WITH FOREST CUTTING, SPECIES CONVERSIONS, AND NATURAL DISTURBANCES,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
W. T. Swank, L. W. Swift, and J. E. Douglass.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 297-312, 10 fig, 5 tab.

Descriptors: *Streamflow, *Ecological effects, *Logging, *Coweeta, *North Carolina, *Forest hydrology, Forest watersheds, Revegetation, Evapotranspiration, Species diversity, Water yield, Hardwood, Pine trees.

Long-term streamflow records for control and experimental forested watersheds at Coweeta provide a solid foundation for evaluating hydrologic responses to vegetation management. Results from these experiments and those elsewhere in the Appalachian Highlands provide equations for predicting changes in annual water yield following cutting and regrowth of hardwood forests. Only two parameters, proportion of the stand basal area cut and potential insolation of the watershed are needed to solve these equations. Increases are produced in most months, with about a 100% increase during the low flow months when water demands are usually high. The recovery of streamflow to preharvest levels associated with hardwood regrowth shows the interactions between Et evapotranspiration (Et), stand dynamics, and watershed physical characteristics. Experiments indicate that commercial clear-cutting, with carefully located and designed roads, produce only small and acceptable (about 15%) increases in mean stormflow volumes and peak flow rates. Natural alteration of vegetation such as insect defoliation can also influence water yield by stimulating leaf production and increasing evapotranspiration, thus reducing winter streamflow by 7 to 18%. Other long-term experiments show the striking dependence of streamflow volume on type of vegetative cover. Within 25 years, hardwood to white pine conversion reduces annual flow by 25 cm and produces significant reductions in every month of the year. Greater Et for pine is due to a higher leaf area index for pine compared to hardwoods, hence, greater interception and transpiration by pine. Hardwood to grass conversion also alters streamflow depending upon grass productivity. There is no significant change in flow with a vigorous grass cover, but as grass productivity declines streamflow increases. Evapotranspiration from a luxuriant herbaceous cover is slightly lower than in mature hardwoods, but later in succession with a mixture of hardwoods, grass, and herbs, Et is equivalent to hardwoods. (See also W89-01691) (Lantz-PTT)
W89-01706

FOREST ACCESS ROADS: DESIGN, MAINTENANCE, AND SOIL LOSS,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
L. W. Swift.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 313-324, 4 fig.

Descriptors: *Forests, *Roads, *Soil loss, *North Carolina, *Coweeta, Road construction, Design standards, Erosion, Gravel, Grading, Erosion control.

The design and construction of, and soil loss from, forest roads have been continuing areas of research and demonstration by the Southeastern Forest Experiment Station since Coweeta Hydrologic Laboratory was established. The low-cost, low-maintenance intermittent-use road pioneered by Coweeta is widely accepted and adapted to local conditions by government and industry land managers, and strongly recommended by state agencies with the aim of reducing sediment, the principal nonpoint source of pollution from forestry activities. Several principles can be drawn from the Coweeta studies. An inexpensive design and field layout procedure can produce a serviceable and environmentally acceptable road. The most effective road system results from a transportation plan developed to serve an entire basin rather than he sum of individual road projects constructed to serve short-term needs. Soil exposed by construction should be revegetated quickly. Where possible, storm waters should be removed from the road at frequent intervals and in small amounts by outsloping and dips, rather than by consolidation into ditch-lines and culverts. Contour roads and gentle grades require less maintenance and produce less sediment. Gravel surfacing is best, but a grassed roadbed is good where traffic is light and can be controlled to exclude use in wet weather. If only a small quantity of gravel is available, it should be applied on climbing grades, poor trafficability soils, in dips, and near stream crossings. The stream crossing is the most critical part of the entire road, and every effort should be made to protect and vegetate fill slopes and divert storm waters on the road away from the stream. Filter strips and brush barriers prevent sediment from reaching streams. Unnecessary maintenance must be avoided. (See also W89-01691) (Lantz-PTT)
W89-01707

STREAM CHEMISTRY RESPONSES TO DISTURBANCE,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
W. T. Swank.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 339-357, 6 fig, 6 tab.

Descriptors: *Stream chemistry, *Logging, *Ecological effects, *Water chemistry, *Forest hydrology, Clear-cutting, Water quality, Nitrates, Nitrogen, Forest watersheds, Evapotranspiration, Ecosystems, Insects.

Long-term measurements of dissolved inorganic constituents of streams draining disturbed watersheds have been made at Coweeta. Disturbances include commercial selection cutting, commercial and noncommercial clear-cutting, conversion of mixed hardwoods to white pine and grass covers, agricultural cropping, and natural disturbances comprised of insect outbreaks. Initiation of stream chemistry studies postdate most watershed treatments and represent conditions at varying periods of time since disturbance. Taken together, the responses in stream chemistry to forest disturbances can be summarized by the following points: (1) Over the period of observation beginning in 1972, none of the disturbances produced nutrient concentrations that would have an adverse impact on water quality for municipalities or downstream fisheries. (2) Compared to other forested regions of the United States, increases in nutrient disturbances. (3) Nitrate-N is a sensitive indicator of forest disturbance and although concentrations are quite low (<0.2 mg/L), elevated levels in streams draining clearcuts appear to persist for at least 20 years after cutting. (4) Comparisons of annual nutrient input and output budgets for control versus disturbed watersheds illustrate the importance of evapotranspiration (Et) processes in regulating biogeochemical cycles. (5) Budget data, combined with process research, also demonstrate the importance of biological processes in nutrient retention and loss from forest ecosystems. Decomposition, net primary production, and uptake and storage of nutrients in successional vegetation are important factors that regulate the magnitude and timing of nutrient exports. (6) Outbreak infestations of two different insects provide evidence for insect regulation of nutrient recycling and at an ecosystem leveled as revealed by changes stream chemistry. (See also W89-01691) (Lantz-PTT)
W89-01709

METHOD FOR TREATMENT OF DATA FROM THE INSTREAM FLOW INCREMENTAL METHODOLOGY FOR INSTREAM FLOW DETERMINATION,
Utah State Div. of Wildlife Resources, Salt Lake City.
W. H. Geer.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 1-25, 5 fig, 15 tab, 5 ref.

Descriptors: *Data interpretation, *Instream flow, *Streamflow, *Trout, *Ecological effects, Instream flow incremental methodology, Mathematical studies, Aquatic habitats, Utah, Case studies, Hydroelectric plants.

The alteration of streamflow regimes is a major cause of degradation of western U.S. trout streams, and several instream flow needs methodologies have been developed to determine both the impacts of streamflow alteration and the streamflow regimes necessary for fishery protection. Perhaps the most widely used is the Instream Flow Incremental Methodology (IFIM) of the U.S. Fish and Wildlife Service. This paper gives stepwise procedures of IFIM data analysis that lead different analysts to similar conclusions on both the impacts of streamflow alteration and streamflow needs. They mathematically incorporate specific aquatic habitat management goals and express the effects of selected streamflow regimes as percentages of a calculated optimum habitat condition for the subject stream. The procedures permit the comparison of altered streamflow regimes to historical conditions and to stream habitat potential. Analytical procedures are demonstrated on actual IFIM data used to assess the fishery impacts of a proposed hydroelectric power project in northern Utah. (See also W89-01736) (Lantz-PTT)
W89-01737

IDAHO HABITAT EVALUATION FOR OFF-SITE MITIGATION RECORD: ANNUAL REPORT 1985,
Idaho Dept. of Fish and Game, Boise.
For primary bibliographic entry see Field 2H.
W89-01777

DETROIT RIVER, MICHIGAN: AN ECOLOGICAL PROFILE,
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
For primary bibliographic entry see Field 2H.
W89-01806

REPORT OF THE FLATHEAD RIVER INTERNATIONAL STUDY BOARD.
International Joint Commission-United States and Canada, Columbus, OH.
July 1988. 235p, 10 fig, 19 tab, 69 ref, 9 append.

Descriptors: *Environmental effects, *Flathead River, *Coal mining, Water quality, Water quantity, Recreation, Fishing, Turbidity, Sedimentation, Nitrogen compounds.

In February 1984, the British Columbia government granted Sage Creek Coal Limited approval-in-principal for a 2.2 million tonnes (2.4 million tons) per year thermal coal mine located 10 km upstream from the International Boundary on Howell and Cabin Creeks, tributaries of the Flathead River. The mine plan is based on 21 years of mining at this rate. Coal reserves, however, exist for a further 20 years of mining at the same rate. The effects of the mine on Cabin and Howell Creeks at and immediately downstream of the mine site are difficult to predict because of the complex interrelationships between surface and groundwater hydrology. In the premining phase, there is a potential for increased flow in these creeks during freshet due to land clearing, and reduced flows during base flow periods due to decreased groundwater discharge. During the early phases of mining, net flows in these creeks are expected to change < 10% due to the counterbalancing of increases from groundwater infiltration and decreases in surface flows due to diversion into the Flathead River. In the later stages of mining, once the pits extend below the valley floor, there is a possibility of reversals in groundwater flows resulting in loss of water from Howell and Cabin creeks to the pits. The effects of sedimentation, turbidity, temperature, nutrients and toxic compounds of nitrogen on water quality are addressed. The Board concludes that the mine would have a detrimental impact on the benthic macroinvertebrate populations within the mine site. There will also be some adverse effects on species closely associated with riparian habitats due to a reduction in the food base for some riparian animals. These effects may extend to the International Boundary. Impacts of the mine on water uses, includes effects on fishing, and/or other recreational activities. (See Also W89-01809) (Lantz-PTT)
W89-01808

SUPPLEMENTARY REPORT OF THE FLATHEAD RIVER INTERNATIONAL STUDY BOARD.
International Joint Commission-United States and Canada, Columbus, OH.
For primary bibliographic entry see Field 5G.
W89-01809

LONG-TERM IMPACTS OF AGRICULTURAL RUNOFF IN A LOUISIANA SWAMP FOREST,
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
J. W. Day, and G. P. Kemp.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 317-326, 3 fig, 1 tab, 20 ref. Louisiana Water Resources Research Institute Grant A-043-2A.

Descriptors: *Agricultural runoff, *Water pollution effects, *Louisiana, *Swamps, *Wetlands, Nitrogen, Phosphorus, Agriculture, Nutrients, Denitrification, Path of pollutants, Dissolved oxygen, Phosphates.

A summary of a two-year research project on the dynamics of nutrient retention and release in a swamp receiving upland runoff is presented. The central objective was to estimate the capacity of this type of wetland for removing nutrients from upland runoff. The role of redox in determining floodwater nutrient concentrations, both in the field and in laboratory microcosms is examined, along with testing the hypothesis that water quality deterioration in the region can be directly related to the cessation of overland water processing formerly performed by the swamp. Under overland flow conditions, the swamp can remove significant amounts of incoming nutrients: 21% of total N and 41% of total P were retained in the swamp. Practically all of the removal takes place because of the settling of particulate N and p. For two reasons, it is not likely that the swamp will become saturated with N and P. First, the results indicate that denitrification is a significant pathway for the permanent loss of N. Second, the swamp is subsiding at a significant rate. In spite of nutrient retention in the swamp, significant amounts are still exported to swamp bayous and lakes. The swamp, however, acts as a buffer in time and composition, as, well as in concentration. Dissolved oxygen in the water column is the single most important factor determining sediment-water exchange of PO_4. (See also W89-01827) (Lantz-PTT)
W89-01848

EVALUATING RISKS OF GENETICALLY ENGINEERED PRODUCTS UNDER THE TOXIC SUBSTANCES CONTROL ACT,
Environmental Protection Agency, Washington, DC. Office of Pesticides and Toxic Substances.
For primary bibliographic entry see Field 5C.
W89-01906

CONTRIBUTIONS OF URBAN ACTIVITIES TO TOXIC CONTAMINATION OF LARGE LAKES,
KBN Engineering and Applied Sciences, Inc., Gainesville, FL.
For primary bibliographic entry see Field 5B.
W89-02157

AGRICULTURE AND NATURAL RESOURCES: THE BROADENING HORIZON,
Michigan State Univ., East Lansing. Coll. of Agriculture and Natural Resources.
For primary bibliographic entry see Field 6A.
W89-02197

PERSPECTIVE ON SOIL AND WATER CONSERVATION AND AGRICULTURALLY RELATED GROUNDWATER CONTAMINATION,
Soil Conservation Service, East Lansing, MI.
H. R. Hilner.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 15-19.

Descriptors: *Nonpoint pollution sources, *Soil conservation, *Water conservation, *Groundwater pollution, *Agriculture, Groundwater recharge, Information exchange, Aquifers, Groundwater quality, Animal wastes, Agricultural chemicals, Erosion control.

Before livestock was concentrated in large numbers on small areas, and before the widespread use of pesticides and chemical fertilizers, there was little potential for seriously contaminating rural groundwater from agricultural sources. With increased rural populations, concentrated livestock production operations, and extensive use of chemicals, including some relatively complex ones, conservation measures must now be planned, designed and installed that will control potentially negative effects. Conservation systems for erosion control and animal waste management typically include measures to handle surface water. However, groundwater levels and quality are often also affected. More sophisticated information, education and technical assistance are needed by farmers and other land users to prevent contamination. Soil Conservation Service personnel and others that advise farmers must be provided with the capability to identify agriculturally related potential groundwater quality problems, sources and ways to evaluate alternative solutions. In the case of groundwater found to be currently seriously contaminated, outside financial and technical assistance will likely be needed, especially when pollution sources are unknown or financial resources of current surface owners are insufficient to conduct cleanup operations. Maps of vulnerable aquifer recharge areas should be prepared and made readily accessible to conservationists and others advising the agricultural community. Consistent, current, comprehensive information on water resources from the surface down to all usable aquifers is needed statewide. In addition, having the capability to manipulate and evaluate the information is essential. Mathematical computer models which link soils, geology, surface and groundwater information will be necessary to handle the large volume of data. Efforts are underway in government agencies and academic institutions such as Michigan State University, the Michigan Department of Natural Resources and the Soil Conservation Service to develop those tools and data. (See also W89-02196) (Lantz-PTT)
W89-02198

4D. Watershed Protection

FOREST HYDROLOGY AND ECOLOGY AT COWEETA.
For primary bibliographic entry see Field 2A.
W89-01691

BIOTECHNICAL SLOPE PROTECTION AND EROSION CONTROL,
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
D. H. Gray, and A. T. Leiser.
Van Nostrand Reinhold Co., New York. 1982. 271p.

Descriptors: *Erosion control, *Slope protection, Vegetation, Retaining walls, Walls, Costs, Labor, Economic aspects, Shorelines, Case studies.

The general principles and advantages of biotechnical slope protection systems are discussed. Low-cost biotechnical measures, such as contour wattling, brush layering, live staking, and brush matting, are described in detail. The use of slope plantings in conjunction with earth-retaining structures is also discussed. This latter technique includes plantings on slopes above low toe-walls, on benches of tiered retaining walls, and in the frontal interstices, or openings, of porous retaining structures, such as crib walls, welded-wire walls, gabions, and cellular revetments. Low-cost, labor-skill intensive, and environmentally compatible methods of slope protection are completely assessed. The comparative costs of various vegetative, structural, and biotechnical measures are

clearly tabulated. Supplementing these cost analyses are case studies that illustrate practical on-the-job applications of slope protection measures. These studies - backshore slope protection along a lakeshore, rehabilitation of slopes disturbed by timber harvesting operations, and cut slope stabilization along a highway - demonstrate the versatility and effectiveness of biotechnical slope protection. (Lantz-PTT)
W89-01811

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

RECOMMENDED APPROACH TO THE EVALUATION OF THE ENVIRONMENTAL BEHAVIOR OF PESTICIDES: IUPAC REPORTS ON PESTICIDES, NO. 24,
CIBA-GEIGY A.G., Basel (Switzerland). Agricultural Div.
H. O. Esser, R. J. Hemingway, W. Klein, D. B. Sharp, and J. W. Vonk.
Pure and Applied Chemistry PACHAS, Vol. 60, No. 6, p 901-932, June 1988.

Descriptors: *Water analysis, *Chemical analysis, *Pesticides, *Pollutants, *Path of pollutants, *Fate of pollutants, *Standards, Soil, Water, Hazard assessment, Population exposure, Environmental effects.

The International Union of Pure and Applied Chemistry, Applied Chemistry Division Commission on Agrochemicals, describes concepts and experimental approaches for the rational testing of the fate of pesticides in soil, water, air, plants and animals. The stepwise test program presented is flexible, cost effective, and ensures that all aspects of a pesticides's environmental fate are studied in sufficient detail. It also includes, at different stages of testing, the results that are relevant to the estimation of exposure to the pesticide, an essential element of the hazard assessment process concerning producers/applicators, consumers and the environment. (Author's abstract).
W89-01296

CELL CULTURE SYSTEMS ARE MORE SENSITIVE THAN SACCHAROMYCES CEREVISIAE TESTS FOR ASSESSING THE TOXICITY OF AQUATIC POLLUTANTS,
Shimane Prefectural Inst. of Public Health and Environmental Science, Matsue (Japan).
K. Mochida, M. Gomyoda, T. Fujita, and K. Yamagata.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 1, p 1-3, July 1988. 1 tab, 13 ref.

Descriptors: *Toxicity, *Bioassay, *Pollutants, *Water pollution, *Heavy metals, *Human cell culture, *Saccharomyces, Yeasts, Cadmium, Mercury, Nickel.

Toxicity assays of aquatic pollutants (Cd, Hg, Ni) using human cell culture systems (KB, HEL-R66) and the yeast Saccharomyces cerevisiae test are reported. The 3 metals were highly toxic to both human cell lines, the 72-h ID50 (concentrations exhibiting a 50% inhibition in growth) values ranging from 3.1 to 120 micromolar. Cd was the most toxic and Ni the least. The same ranking toxicity was also obtained in the S. cerevisiae assay. The comparative data indicate that cell culture systems are more sensitive than the S. cerevisiae test for evaluating the toxicity of these 3 pollutants. The ID50 values can serve as a basis for evaluating the hazards of chemicals on aquatic environments. (Sand-PTT)
W89-01297

DETECTION OF DRILLING MUD-BASE OIL IN THE BILE OF TROUT, SALMO GAIRDNERI,
Department of Fisheries and Oceans, St. John's (Newfoundland). Science Branch.
For primary bibliographic entry see Field 5B.
W89-01301

NEW SELECTIVE AGAR MEDIUM FOR RECOVERY OF STAPHYLOCOCCUS AUREUS IN WATERS (UTILISATION D'UN NOUVEAU MILIEU DE CULTURE SELECTIF POUR L'ISOLEMENT DE STAPHYLOCOCCUS AUREUS DANS DIFFERENTS TYPES D'EAU),
Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
P. Lebaron, and B. Baleux.
Comptes Rendus de l'Academie des Sciences (Series 3) CHDDAT, Vol. 306, No. 10, p 317-320, March 14 1988. 8 ref. English summary.

Descriptors: *Bacterial analysis, *Water analysis, *Staphylococcus, Culture media, Agars, Sewage bacteria.

Different media available for recovering Staphylococcus aureus are not adapted for water analysis because of their low selectivity. A new medium is proposed which uses Baird Parker agar medium with sodium azide and is incubated at 37 C for 24 h. Three kinds of waters are tested: the efficiency of this medium is higher for surface water using a modified technique of filtration. (Author's abstract)
W89-01310

RADIOACTIVITY IN WATER SUPPLIES,
For primary bibliographic entry see Field 5F.
W89-01352

DETERMINATION OF TWENTY-ONE CHLOROANISOLES IN WATER AND SEDIMENT SAMPLES,
National Water Research Inst., Burlington (Ontario). Research and Applications Branch.
H.-B. Lee.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 71, No. 4, p 803-807, July/August 1988. 5 fig, 3 tab, 12 ref.

Descriptors: *Chemical analysis, *Water analysis, *Pollutant identification, *Chloroanisoles, *Phenols, *Sediments, Chlorides, Path of pollutants, Laboratory equipment, Gas chromatography, Mass spectroscopy.

A simple and sensitive method for the determination of 19 chloroanisoles and 2 chloromethylanisoles was developed for water; another method was developed for sediment samples. Water samples were extracted with dichloromethane; sediments were extracted with a mixture of hexane and acetone in a Soxhlet apparatus. The extracts were concentrated on a Snyder column and then were cleaned up on an activated Florisil column. The anisoles were separated by either an OV-1 or SPB-5 capillary column and were detected by an electron-capture of a mass selective detector. Recoveries of chloroanisoles in fortified water and sediment samples generally ranged between 70 and 85%. The method detection limits were 0.02 micrograms/L and 0.002 micrograms/g for mono- and di-chloroanisoles in water and sediments and 0.002 micrograms/L and better than 0.001 micrograms/g for tri-, tetra-, and penta-chloroanisoles in those matrices. The electron-impact mass spectra of all chloroanisoles exhibited intense peaks for the molecular ions (M+), as well as (M-43)+ or (M-30)+ fragments. These masses were used as characteristic ions for quantitative and confirmation purposes. (Author's abstract)
W89-01377

DIFFERENTIAL COURTSHIP ACTIVITY AND ALTERATIONS OF REPRODUCTIVE SUCCESS OF COMPETING GUPPY MALES (POECILIA RETICULATA PETERS; PISCES: POECILIIDAE) AS AN INDICATOR FOR LOW CONCENTRATIONS OF AQUATIC POLLUTANTS,
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.).
J. H. Schroeder, and K. Peters.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 385-390, September 1988. 1 fig, 3 tab, 11 ref.

Descriptors: *Reproduction, *Guppies, *Courtship, *Bioindicators, *Bioassay, *Wastewater pollution, Sublethal effects, Water pollution effects, Genetics, Pollutant identification.

Differential courtship activity of guppy males competing for the same females were used as a bioindicator for low concentrations of water-borne pollutants in a previous study. It has been predicted that the decrease in mean differential courtship after exposure to aquatic contaminants causes a corresponding change in the relative reproductive success. However, this prediction could not be tested in the previous study because only gravid females were used. The present study completed the previous one by repeating the experiment with a 10% addition of wastewater drawn from the last clearing basin of a Munich purification plant, this time using virgin (non-inseminated) females which were receptive to male courtship. The females subsequently were allowed to produce as many offspring as possible. The number of young guppies sired by individual male competitors could easily be traced by the use of sex-linked phenotypic color patterns as markers. The two T-chromosomal marker genes were labeled Ma and Ir. Apart from both frequency and duration of the courtship activities of Ir males, all differences between controls and 10% wastewater treatment groups were found to be significant. As far as Ma males are concerned, all activities were significantly changed. The higher reproductive success of Ma males exposed to wastewater is due to the higher courtship activities of those males relative to the Ir competitors. (VerNooy-PTT)
W89-01395

TREATING INDUSTRIAL PLANT WASTEWATER: MEETING TODAY'S COMPLIANCE CHALLENGES,
BCM Engineers, Mobile, AL.
For primary bibliographic entry see Field 5D.
W89-01400

ENVIRONMENTAL ANALYSIS USING AN ENERGY-DISPERSIVE X-RAY FLUORESCENCE ANALYZER,
HNU Systems, Inc., Newton, MA.
For primary bibliographic entry see Field 7B.
W89-01439

LOW LEVELS OF COPPER AND LEAD IN A HIGHLY INDUSTRIALIZED RIVER,
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
For primary bibliographic entry see Field 7B.
W89-01442

ARSENIC SPECIATION AND QUALITY OF GROUNDWATER IN A LEAD-ZINC MINE, IDAHO,
Idaho Univ., Moscow. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-01456

EVALUATION OF DIRECT MICROSCOPICAL COUNTS AND ENDOTOXIN MEASUREMENTS AS ALTERNATIVES FOR TOTAL PLATE COUNTS,
Kongelige Veterinaer- og Landbohoejskole, Copenhagen (Denmark). Inst. of Veterinary Microbiology and Hygiene.
E. Korsholm, and H. Sogaard.
Water Research WATRAG, Vol. 22, No. 6, p 783-788, June 1988. 4 fig, 4 tab, 21 ref.

Descriptors: *Water analysis, *Bacterial analysis, *Pollutant identification, *Drinking water, *Toxins, *Endotoxins, Acridine orange, Comparison studies, Biomass, Fluorescence, Limulus amoebocyte lysate test, Lipopolysaccharides, Variability, Statistics.

Acridine orange direct counts (AODCs) were compared with endotoxin (lipopolysaccharide, LPS) concentrations in 233 unchlorinated drinking water samples. Different fractions of LPS (total, free, and bound) were obtained by centrifuging the samples and were determined using a chromogenic Limulus amoebocyte lysate (LAL) test kit. Correlations with AODC were not increased when the bound LPS fraction was used instead of total LPS. For the total numbers samples the correlation between total LPS and AODC was relatively high (r = 0.80), but with a residual standard deviation indicating considerable variations in the mean LPS content per cell from sample to sample. The obtained best-fitting regression line was significantly dependent on both water type and water processing plant; likewise, different borings within the same water supply seemed to influence the LPS/AODC ratio. It is concluded that the AODC method is more reliable than LPS measurements when determining the total number of viable bacteria present, and seems to represent a good alternative to the traditional plate count method. Based on an apparent relation between the LPS concentration and the judged mean cell size, the value of the LAL test in estimating biomass is indicated, and with an extensive and fairly homogeneous sample material (e.g., in acute contamination situations), the ease and speed of the LAL test would favor this method. (Author's abstract)
W89-01458

INORGANICS,
Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA. Montgomery Labs.
A. Eaton.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 752-773, June 1988. 10 tab, 440 ref.

Descriptors: *Literature review, *Inorganic compounds. *Wastewater analysis, *Pollutant identification, *Water analysis, *Chemical analysis, Quality control, Chromatography, Spectroscopy, Electrochemistry, Flow injection analysis, Heavy metals, Ions, Radionuclides, Rare earths, Alkalinity, Nutrients, Hydrogen ion concentration, Suspended solids, Trace elements, Measuring instruments, Data collections.

Literature published in 1987 on chemical analysis of inorganics is summarized in the form of tables covering the following: quality assurance and sampling procedures, sample preparation and preconcentration, speciation of elements, chromatography (ion, gas, and high pressure), atomic spectroscopy (atomic absorption, ICP, and ICP-mass spectroscopy), electrochemistry (cathodic stripping, anodic stripping, and ion-selective electrodes), flow injection analysis, other instrumental techniques, spectrographic techniques, and analysis of individual elements and compounds (alkalinity, Al, Sb, As, Ba, Bi, B, Br, Cd, COD, Cu, CN, F, Ge, Au, I, Fe, Pb, Li, Mn, Hg, Mo, Ni, NH3, NO3, NO2, total Kjeldahl N, Os, Pd, pH, P, Pt, radionuclides, rare earths, Re, Se, Si, Ag, Sr, SO4, S, sulfite, thiosulfate, total suspended solids, Tl, Sn, Ti, W, U, V, and Zr. All tables consist of comments summarizing each document cited. (Rochester-PTT)
W89-01464

ORGANICS,
Tennessee Technological Univ., Cookeville.
M. E. Nubbe, V. D. Adams, R. J. Watts, and Y. S. Robinet-Clark.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 773-796, June 1988. 8 tab, 292 ref.

Descriptors: *Literature review, *Organic compounds, *Wastewater analysis, *Water analysis, *Pollutant identification, *Chemical analysis, *Path of pollutants, *Fate of pollutants, *Groundwater pollution, Hydrocarbons, Pesticides, Chlorinated hydrocarbons, Organic matter, Surface water, Groundwater, Drinking water, Wastewater, Data collections.

Literature published in 1987 on determination of organics and the presence and behavior of organics in environmental samples is summarized. Total organic determination is reviewed and pertinent, important and significant articles are summarized in the form of tables. Tables cover the following topics: methods of identification and detection of detergents and related compounds; methods of identification and quantification of aliphatic and aromatic hydrocarbons; presence, degradation, and attenuation of aliphatic and aromatic hydrocarbons; methods for identification and quantification of pesticides, chlorinated hydrocarbons, and related compounds; presence, degradation, and attenuation of pesticides, chlorinated hydrocarbons, and related compounds; methods for identification and quantification of naturally occurring organics; methods for identification of organics present in surface and groundwater, drinking water, wastewater, and other media; and presence, degradation, and attenuation of organics in surface and groundwater and wastewater. For each table, the sample type (e.g., groundwater, leachate, soil), compounds analyzed, methods employed, and significant results are given. (Rochester-PTT)
W89-01465

WATER CHARACTERISTICS,
A. D. Levine.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 796-801, June 1988. 1 tab, 42 ref.

Descriptors: *Literature review, *Wastewater analysis, *Water analysis, *Acid rain, *Chemical analysis, *Measuring instruments, Color, Odor, Dissolved oxygen, Hydrogen ion concentration, Solids, Particulate matter, Monitoring, Remote sensing, Radionuclides, Heavy metals, Trace elements, Sulfates.

Literature published in 1987 on biological and physical methods of water and wastewater analysis is summarized under the following headings: biological analytical techniques, physical and chemical analytical techniques, and acid precipitation. Specific measurement topics covered are: color, odor, dissolved oxygen, pH, solids, particulates, remote monitoring of groundwater, and radionuclides. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01466

CONTINUOUS MONITORING, AUTOMATED ANALYSIS, AND SAMPLING PROCEDURES,
Oak Ridge National Lab., TN. Waste Management Technology Center.
For primary bibliographic entry see Field 7B.
W89-01467

HUMAN HEALTH EFFECTS ASSAYS,
Utah Water Research Lab., Logan.
R. C. Sims, J. L. Sims, and R. R. Dupont.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 1093-1106, June 1988. 6 tab, 253 ref.

Descriptors: *Literature review, *Public health, *Human diseases, *Water analysis, *Bioassay, *Carcinogens, *Genotoxic chemicals, *Mutagens, *Drinking water, *Surface water, Data collections, Pollutant identification, Organic compounds, Water pollution effects.

Literature published in 1987 on assays used in environmental risk assessment in relation to water pollutants is summarized, including: current approach, test systems, and research results. Tables summarize properties of assays used for genotoxic chemicals in environmental samples; results of health effects assays of drinking waters and surface waters; health effects assays of specific organic chemicals or chemical classes of environmental concern; and special characteristics of human health effects assays of mutagenicity and genotoxic effects. (Rochester-PTT)
W89-01506

DETECTION AND OCCURRENCE OF WATERBORNE BACTERIAL AND VIRAL PATHOGENS,
Virginia Polytechnic Inst., Blacksburg.
G. D. Boardman, R. D. Shannon, and T. R. McBrayer.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 1121-1132, June 1988. 178 ref.

Descriptors: *Literature review, *Water treatment, *Bacteria, *Viruses, *Pathogens, *Path of pollutants, *Water analysis, Bacterial analysis, Fate of pollutants, Serology, Culture media, Sampling, Wastewater analysis, Activated sludge, Wetlands, Performance evaluation, Filtration, Disinfection.

Literature published in 1987 on detection and occurrence of waterborne bacterial and viral pathogens in water is summarized under the following headings: bacteria detection, occurrence and distribution of bacteria, fate of bacteria in water treatment systems, persistence of bacteria, bacterial indicators, virus detection, virus distribution and occurrence, fate of viruses in treatment systems, persistence of viruses, and viral indicators. Topics include membrane filtration sampling, culture media, serological methods, antibiotic-resistant bacteria, effects of chlorine, ozone, and biological treatment, point-of-use disinfection, bacteria and viruses in freshwater, marine, and wastewater environments, and fate of viruses in activated sludge and artificial wetlands. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01508

INFLUENCE OF INDICATOR BACTERIA ON THE INCIDENCE OF SALMONELLA IN AQUATIC ENVIRONMENT,
Hiroshima Univ. (Japan). Faculty of Applied Biological Science.
K. Venkateswaran, and H. Hashimoto.
Nippon Suisan Gakkaishi NSUGAF, Vol. 54, No. 2, p 253-258, February 1988. 2 fig, 3 tab, 21 ref. Japanese Ministry of Education, Culture and Science Grant 60030055.

Descriptors: *Salmonella, *Bioindicators, *Water pollution, *Fecal pollution, *Water quality, Microbiological studies, Bacteria, Surface water, Japan.

A year-long survey was conducted on the ecology of Salmonella and the correlation of bacterial indicators of pollution in the isolation of this enteric pathogen. MPN procedures were employed for the enumeration of total viable counts, total coliforms, fecal coliforms and fecal streptococci in surface waters of riverine and marine biotypes of Fukuyama, Japan. A modified primary, nonselective, elevated temperature preenrichment procedure was used in detecting MPN indices of Salmonella. The results suggested that bacterial indicators of pollution were not reliable as an index of microbial quality of aquatic system and emphasized that direct enumeration of Salmonella could serve as an indicator of the quality of water. Serological studies of 321 strains of Salmonella yielded 11 serotypes with one untypable strain. S. agona, S. champaign and S. litchfield were isolated for the first time in Fukuyama aquatic environments. In addition, one new serotype, S.III b 58: z sub 10: z sub 53: Rz sub 50, is reported (Author's abstract)
W89-01510

PHAGE-SENSITIVE BACTERIA IN SEAWATER OF KAGOSHIMA BAY, (IN JAPANESE),
Kagoshima Univ. (Japan). Faculty of Fisheries.
T. Hidaka, Y. Kamino, and T. Kawabe.
Memoirs of the Faculty of Fisheries, Kagoshima University, Vol. 36, No. 1, p 17-25, 1987. 3 fig, 3 tab, 11 ref. English summary.

Descriptors: *Sea water, *Bacteria, *Oseudomonas, *Vibrio, *Moraxella, *Pollutant identifica-

tion, *Aeromonas, *Bacteriophage, *Aquatic habitats, Habitats, Kagoshima Bay, Bays, Japan, Coastal waters.

Marine bacteria and bacteriophages were isolated from seawater samples collected from 1 m and 50 m depth layers at 8 stations of Kagoshima Bay, at 11 times of selected seasonal intervals during 1980 to 1984. The isolates from each sample included several phage-sensitive strains. The proportion of phage-sensitive to total isolates from each sample varied from 0 to 87 percent (average 25 percent), at each station, depth, and season. The sensitive strains were found in all genera of isolates, especially Pseudomonas, Vibrio, Aeromonas and Moraxella. The strains in each genus could be categorized by their sensitivity to several phage types. Their habitats were segregated by station and depth. It was found that the strains' distribution was dependent on oceanographic conditions in the Bay. (Author's abstract)
W89-01523

ATOMIC ABSORPTION SPECTROMETRIC AND SYNERGISTIC SPECTROPHOTOMETRIC MICRODETERMINATION OF HAFNIUM IN ALLOYS AND ENVIRONMENTAL SAMPLES,
Centre for Water Resources Development and Management, Kunnamangalam (India). Water Quality and Environment Div.
S. A. Abbasi.
Analytical Letters ANALBP, Vol. 21, No. 4, p 653-665, June 1988. 1 fig, 4 tab, 21 ref.

Descriptors: *Hafnium, *Extraction, *Atomic absorption spectrometry, *Pollutants, *Pollutant identification, Water pollution, Spectrometers, Spectrophotometry, Analytical methods.

Hafnium (IV) was selectively extracted from 0.45-0.55 M HCl media as its chelate with N-p-methoxyphenyl-2-furylacrylic-hydoxamic acid (MFHA) into chloroform. Xylenol orange was added to the extract to form an intensely colored ternary complex measurable spectrophotometrically at 545 nm (epsilon = 8.3 times 10 to the fourth l/mol/cm) with a sensitivity better than 0.002 ppm. For atomic absorption spectrometric determination, hafnium was extracted with MFHA into methyl isobutyl ketone was measured with 286.6 nm resonance line in the nitrous oxide-acetylene flame. The methods were applied to the analysis of hafnium in alloys, plant tissues, animal tissues, and natural waters. The MFHA-xylenol orange reagent combination was chosen after studying ten hydroxamic acids and five chromogenic reagents. (Author's abstract)
W89-01526

PROCEEDINGS OF THE NWWA/API CONFERENCE ON PETROLEUM HYDROCARBONS AND ORGANIC CHEMICALS IN GROUND WATER-PREVENTION, DETECTION AND RESTORATION.
For primary bibliographic entry see Field 5B.
W89-01530

INSTALLATION OF HYDROCARBON DETECTION WELLS AND VOLUMETRIC CALCULATIONS WITHIN A CONFINED AQUIFER: A CASE STUDY,
Engineering Enterprises, Inc., Norman, OK.
For primary bibliographic entry see Field 7A.
W89-01545

USE OF HEADSPACE SAMPLING TECHNIQUES IN THE FIELD TO QUANTIFY LEVELS OF GASOLINE CONTAMINATION IN SOIL AND GROUND WATER,
Connecticut Univ., Storrs. Dept. of Chemistry.
G. A. Robbins, V. D. Roe, J. D. Stuart, and J. T. Griffith.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 307-315, 2 fig, 7 ref.

Descriptors: *Pollutant identification, *Groundwater pollution, *Soil contamination, *Gasoline, *Monitoring, *Sampling, Vapor pressure, Leakage, Quantitative analysis, Path of pollutants.

Headspace sampling entails measuring the concentration of analyte vapors in the air space of a sampling vessel that contains contaminated soil or water. Ideally, headspace concentration measurements should be correlative with contaminant levels in soil and water. Thus, they should be useful for real-time contamination assessments related to investigations, monitoring and remediation. However, in general practice, headspace and laboratory correlations are often problematic, as exemplified by poor correlations, and false positive and negative field indications of contamination relative to standard laboratory analyses. Theoretical evaluations and laboratory and field testing are being conducted to develop improved headspace methodologies. These methodologies include gross contamination determinations in pressure vessels using portable gas detection equipment. Efforts to date would indicate that improvements in measurements and correlations can be performed, and important variables that influence measurements are recorded and controlled. Important variables include sample size/headspace volume ratio, temperature, total pressure, sealing time interval prior to measurement, contaminant mass, background vapor levels in pore spaces, vessel leakage during sampling, and vapor condensation on the sampling vessel. (See also W89-01530) (Author's abstract)
W89-01548

HYDROCARBON VAPOR PLUME DEFINITION USING AMBIENT TEMPERATURE HEADSPACE ANALYSIS,
ERT, A Resource Engineering Co., Fort Collins, Co.
T. Holbrook.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 317-328, 4 tab, 6 ref.

Descriptors: *Hydrocarbons, *Soil contamination, *Pollutant identification, *Monitoring, *Sampling, *Gasoline, *Soil temperature, Plumes, Path of pollutants, Vadose water, Storage tanks, Leakage, Unsaturated zone.

Rapid, on-site methods of determining volatile hydrocarbon concentrations in soil gas are useful in defining the extent of unsaturated zone contamination. Controlled laboratory experiments have been completed to investigate the accuracy and precision of the ambient temperature headspace (ATH) method of analyzing soil samples for volatile hydrocarbons. Soil samples spiked with known amounts of gasoline were tested using the ATH method. The results demonstrate that the method is sensitive to low mg/kg quantities of gasoline in soil samples. Based on these findings, a standard protocol for ATH analysis has been developed. ATH analysis consists of filling a sample container half full with a consistent volume of soil sample, sealing the container, allowing adequate time for ambient temperature equilibration, and finally testing the headspace for volatile ionizable hydrocarbons using a portable photoionization detector (PID). Soil samples collected at incremental depths and analyzed using the ATH method can yield depth integrated data to define the vertical extent of volatile contaminants. In a case study, the ATH method was used on soil samples collected at incremental depths to define the extent of a volatile petroleum plume. ATH results were compared to data obtained by analyzing selected soil samples using more expensive and time consuming EPA extraction and chromatographic methods. By using ATH on soil samples rapid, economical definition of volatile contaminant plumes in the vadose zone can be achieved. (See also W89-01530) (Author's abstract)
W89-01549

MULTI DEPTH SOIL GAS ANALYSES,
San Diego State Univ., CA. Dept. of Geological Sciences.
T. F. Zdeb.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 329-343, 6 fig, 3 tab, 10 ref.

Descriptors: *Soil contamination, *Groundwater pollution, *Organic compounds, *Monitoring, *Adsorption, *Sampling, Soil gases, Gas chromatography, Pollutant identification, Path of pollutants, Water pollution sources.

Multiple depth soil gas surveys, using both passive and dynamic sampling techniques, were completed at a site contaminated at two locations with volatile organic compounds (VOCs). Passive sampling (diffusion driven) was accomplished by placing sampling devices that contained the VOC adsorbent materials, Tenax GC, or Carbopack B, in capped, hollow probes, driven to a four foot depth. Dynamic sampling was effected using a vacuum pump to withdraw subsurface soil gas samples from the passively sampled probes, after sampling was completed, and from new probes driven four and/or nine feet into the ground. At selected locations, discrete samples were collected with a syringe and were analyzed for specific constituents by direct injection into a field-operable laboratory grade gas chromatograph (GC). At the same time, selected samples were also dynamically collected by trapping on the VOC adsorbent material Tenax GC. Samples collected on adsorbent materials were later partially or completely thermally desorbed and analyzed with the GC. A comparison of the results showed that each of the methods of sampling and analyses were useful in terms of defining source areas and that each method had an appropriate application. Dynamic sampling, using on site analysis techniques, had advantages in situations requiring the use of essentially real time data to further direct field activities. The use of adsorbent materials, using both dynamic and passive sampling techniques, was advantageous in that minimal field time and equipment were required to complete the survey. For the methodology applied, the use of adsorbent materials, by the dynamic sampling technique, appears to be capable of producing results that are generally as good as or better than those obtained using direct injection techniques in terms of both sensitivity and economy. Passive sampling produced results that allowed relative concentration gradients to be discerned which may be adequate information in many cases. Problems of contaminated adsorbent materials were largely eliminated by the use of a new type of sampling cartridge. The multi depth approach allowed a preliminary assessment of the nature of the contamination (shallow soil vs. groundwater) to be made. (See also W89-01530) (Author's abstract)
W89-01550

SOIL GAS SURVEY AS A PRELIMINARY INVESTIGATIVE TOOL FOR HYDROCARBON RELEASES: COST-EFFECTIVE FIELD TECHNIQUES AND AN EVALUATION OF FACTORS INFLUENCING THE EFFECTIVENESS OF THE SURVEY,
IEP, Inc., Northborough, MA.
C. Morgan, and C. Klinger.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 347-355, 1 tab.

Descriptors: *Monitoring, *Soil gases, *Pollutant identification, *Groundwater pollution, *Organic compounds, *Soil contamination, *Sampling, Gas chromatography, New England, Vadose water, Soil surveys.

The soil gas survey is a rapid and cost-effective method for providing preliminary assessments of sites where releases of volatile organics to the subsurface are suspected. The relatively simple field techniques described in this paper and elsewhere for sampling of shallow soil gases require only qualified personnel, simple sampling devices, and a field gas chromatograph. In most geologic environments in New England, this technique

seems to be reliably capable of detecting groundwater contamination down to the hundreds of parts per billion level. In favorable circumstances, greater sensitivity may be obtained, but where depth to water exceeds 15 to 20 feet and other factors such as surface permeability are not favorable, sensitivity decreases to detection of groundwater contamination in the part per million range or worse. The survey is thus a viable reconnaissance tool for much of the land area of New England, where depth to water is often not great. As the soil gas survey becomes an increasingly common tool, more and more people will be required to interpret soil gas data, either generated by themselves or in a review capacity. The data presented in this paper is intended to aid those required to interpret soil gas data. (See also W89-01530) (Author's abstract)
W89-01551

SOIL GAS ANALYSIS OF METHANE AND CARBON DIOXIDE: DELINEATING AND MONITORING PETROLEUM HYDROCARBONS,
D. L. Marrin.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 357-367, 3 fig, 1 tab, 12 ref.

Descriptors: *Pollutant identification, *Soil gases, *Sampling, *Monitoring, *Methane, *Carbon dioxide, *Groundwater pollution, *Soil contamination, Benzenes, Regression analyses, Degradation, Hydrocarbons, Plumes, Water pollution sources.

Measuring carbon dioxide concentrations in soil gas overlying an aquifer contaminated with benzene and chlorobenzene provided an estimate of groundwater conditions even though both contaminants were absent from soil gas. Regression analyses suggest that elevated CO_2 concentrations in soil gas were due to organic, rather than inorganic, sources in groundwater. Carbon dioxide concentrations ranged from 0.09 to 0.45% over the groundwater plume. Methane concentrations in soil gas were correlated with total hydrocarbon concentrations in soil gas overlying a free-product layer on the water table. It appeared that methanogenic conditions were associated with the free-product phase and that anomalously high methane concentrations in soil gas beyond the free-product plume were due to either a broken sewer line or the oxidative degradation of gasoline hydrocarbons in shallow soils located beyond the plume boundary. (See also W89-01530) (Author's abstract)
W89-01552

AQUATIC MONITORING: A RATIONALE FOR OBTAINING AND INTERPRETING AQUATIC ECOSYSTEM CHEMICAL EXPOSURE DATA,
Monsanto Co., St. Louis, MO.
For primary bibliographic entry see Field 7A.
W89-01600

LEACHING TEST CHARACTERIZATION OF IRON AND STEEL INDUSTRY WASTE,
Thyssen A.G., Duisburg (Germany, F.R.).
J. A. Philipp, R. Endell, J. Raguin, and O. Dechelette.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 7-27, 5 fig, 11 tab, 20 ref, append.

Descriptors: *Hazardous wastes, *Leaching, *Waste characteristics, *Toxicity, *Waste disposal, Landfills, Testing procedures, Steel industry, Heavy metals, Iron, Waste management, Federal Republic of Germany, South Africa, Australia, France, Great Britain, Italy, Japan, Leachates.

The iron and steel industry generates considerable tonnages of solid waste, and although much of it is to a large extent valorized, some 50 kg of waste to every ton (1000 kg) of steel have to be discharged or disposed of as waste. A good environmental protection policy calls for a ban on dumping of special waste materials, which there are strong grounds for fearing may be of a toxic and dangerous nature. Except in specific cases, it is difficult to tell from the composition of a waste material whether or not it is of a special nature. Characterization simulations have to be made to ascertain the extent to which the waste material can release harmful elements, such as heavy metals, when in contact with rainwater and in some cases other waste materials. Such is the object of the leaching tests, which have or are being developed in many countries at the instigation of the authorities and industrialists: Federal Republic of Germany, South Africa, Australia, France, Great Britain, Italy, Japan, and the United States. The International Iron and Steel Institute has, within its Environment Committee, made a comparison of the results obtained with different national tests using the same specimens. (See also W89-01634) (Author's abstract)
W89-01635

COMPARISON OF LEACHATE QUALITY IN FOUNDRY WASTE LANDFILLS TO LEACH TEST ABSTRACTS,
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W89-01636

TESTING METHODOLOGIES FOR LANDFILL CODISPOSAL OF MUNICIPAL AND INDUSTRIAL WASTES,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-01637

APPROACH FOR EVALUATING LONG-TERM LEACHABILITY FROM MEASUREMENT OF INTRINSIC WASTE PROPERTIES,
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
P. Cote, T. R. Bridle, and A. Benedek.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 63-78, 7 fig, 1 tab, 21 ref.

Descriptors: *Waste characteristics, *Leaching, *Waste disposal, *Hazardous wastes, *Industrial waste, *Mathematical models, Heavy metals, Leachates, Path of pollutants, Permeability coefficient, Model studies, Solid waste disposal.

A radically new approach for evaluating hazardous waste leachability is presented. In the past, leachability has been measured through conductance of laboratory leaching tests, either batch or column, using experimental conditions that attempt to simulate field conditions. An approach is proposed in which measured intrinsic properties of a waste are used in mathematical models to infer the long-term leachability. To provide background information, laboratory leaching tests are reviewed with emphasis on interpretation of the results. It is argued that results of bench-scale tests are difficult to scale up to field disposal conditions and that they do not lend themselves to extrapolation over time. Leaching from wastes takes place via solubilization of contaminants inside the matrix and transport through the matrix pore system to the surrounding aqueous solution. Intrinsic properties that determine leaching rates can be categorized as chemical or transport phenomenon. Chemical properties include those factors that determine a contaminant's solubility, for example, chemical speciation, precipitation, adsorption, kinetics of reaction, buffering capacity, and so forth. Transport properties include structure of the pore system, factors affecting diffusion of ions in the pores, and hydraulic conductivity. Laboratory methods to measure these properties are briefly described. A mathematical model, developed to predict leaching of toxic metals from solidified wastes under acidic conditions, is described. The model uses measured properties of wastes to predict leaching rates under a variety of conditions. Verification experiments are presented and the merits and limitations of the model for long-term predictions are discussed. (See also W89-01634) (Author's abstract)
W89-01638

USE OF AN UPFLOW COLUMN LEACHING TEST TO STUDY THE RELEASE PATTERNS OF HEAVY METALS FROM STABILIZED/SOLIDIFIED HEAVY METAL SLUDGES,
Army Environmental Hygiene Agency, Aberdeen Proving Ground, MD. Waste Disposal Engineering Div.
T. M. Brown, P. L. Bishop, and D. L. Gress.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 79-90, 5 fig, 3 tab, 13 ref.

Descriptors: *Hazardous wastes, *Portland cements, *Leaching, *Heavy metals, *Sludge disposal, Landfills, Particle size, Diffusion coefficient, Path of pollutants, Mathematical models, Cadmium, Chromium, Lead.

Stabilization/solidification of hazardous liquids and sludges with portland cement has been investigated as a method of treatment that will bind hazardous materials in a form that minimizes adverse effects on the environment after landfilling. Research has been conducted to determine the long-term acceptability of this technique for disposal of heavy metal sludges by determining the rate of release of metals from solidified/stabilized wastes. The primary concern of this research was to determine the manner in which the heavy metals are released from the paste, as this will be important in extrapolation of the short-term leaching test results to long time periods. These studies utilized upflow leaching columns to determine the effects of acid flux (meq/g/day) and waste particle size on the release of metals from the solidified cement paste containing heavy metal sludges. Two particle size ranges and two acid fluxes were evaluated. Leachates from the column were collected on a daily basis and analyzed for pH, alkalinity, cadmium, chromium, and lead. Release patterns were modelled successfully using a diffusion-based equation. An effective diffusion coefficient and leachability index were calculated for each combination of heavy metal, particle size, and acid flux. These values can be used to predict metal release rates. (See also W89-01634) (Author's abstract)
W89-01639

COMPLEX MATRIX IN ENVIRONMENTAL CHEMISTRY FOR THE PETROCHEMICAL INDUSTRY,
Standard Oil Co. (Ohio), Cleveland. Research Center.
A. R. Rohlik.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume, American Society for Testing and Materials, Philadelphia, PA. 1986. p 257-272, 4 tab, 7 ref.

Descriptors: *Chemical analysis, *Sample preservation, *Sampling, *Waste characteristics, *Pollutant identification, *Oil industry, Waste disposal, Sulfides, X-ray fluorescence, Models, Sludge, Systems analysis.

Specific examples are presented of problem solving involving the complex matrix to encourage development and comparison of methods with the goal of creating systematic analytical protocols for many waste types. Complex matrix chemistry is becoming more important in environmental analysis. Many waste matrices are unique to an industrial process and common worldwide. Only recently has analysis of many complex wastes been attempted, primarily because of environmental concerns and regulations. The complex matrix can be multiphase, chemically unstable, and contain analytical interferences. Complicating factors include waste aging and total versus releasable constituents. Multiphase wastes can contain organic compounds, water, and solids. Examples of centrifugation and extraction of sludges are shown to simplify analysis. The extracts are more uniform and can be analyzed separately with more reproducible results. However, careful attention must be paid to

mass, volume, and specific gravity of the separated fractions to be able to reconstruct the original samples. Anaerobic bacteria in petroleum refinery sludges can rapidly generate sulfide in a sample and lead to misleading conclusions about the real hazard of the waste. Analysis for sulfide immediately after sampling is recommended. Other changes in chemically active wastes, including oxidation, often occur naturally in the disposal environment. These changes caused by aging are shown to confound analytical results and make interpretation of environmental impact difficult. Matrix interferences in sulfur analyses can be overcome with appropriate analytical techniques. Matrix effects are explained, and comparisons of X-ray fluorescence and combustion are made. The sulfur result is also shown to present a problem in heat content calculation. The success of total assay of metals is dependent on specimen preparation. A comparison of three methods is given and a recommendation made. New test methods under development for environmental modeling are presented. The use of background information is recommended to optimize analytical techniques and provide the most useful data. (See also W89-01634) (Author's abstract)
W89-01649

DETERMINATION OF SOME MACRONUTRIENTS AND MICRONUTRIENTS AND SOME TOXIC ELEMENTS IN SEWAGE SLUDGES FROM DOMESTIC AND INDUSTRIAL INFLUENTS PRIOR TO LAND DISPOSAL: I. DEVELOPMENT OF METHODS,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Chemistry.
S. A. Katz, and S. W. Jenniss.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 273-292, 10 tab, 56 ref.

Descriptors: *Spectroscopy, *Spectrophotometry, *Nutrients, *Hazardous wastes, *Pollutant identification, *Waste characteristics, *Sludge disposal, Phosphorus, Nitrates, Land disposal, Industrial wastes, Municipal wastes, Heavy metals, Testing procedures, Wastwater analysis, Regulations.

Procedures for the determination of some micronutrients and macronutrients and some toxic elements in sewage sludge are reviewed and evaluated. Digestion with nitric acid and hydrogen peroxide prior to measurement by atomic absorption spectroscopy was well suited to the determination of heavy metals in sewage sludge and compatible with the existing requirements and recommendations of the North American and Western European regulatory agencies. Ignition was found to satisfactorily prepare sewage sludge for the determination of phosphorus by spectrophotometry of the molybdenum blue complex, and extraction with water shows promise for isolating nitrites and nitrates from sewage sludge before their spectrophotometric determinations. The criteria used in evaluating the procedures were speed, simplicity, sensitivity, and selectivity. (See also W89-01634) (Author's abstract)
W89-01650

SOIL MOISTURE MONITORING AND SAMPLING PROBE FOR UNDERGROUND STORAGE TANKS AND SURFACE IMPOUNDMENTS,
Wisconsin Univ., Madison. Dept. of Soil Science.
R. Morrison, and D. Mioduszewski.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 343-352, 2 fig, 36 ref.

Descriptors: *Monitoring, *Soil moisture meters, *Soil water, *Leakage, *Storage tanks, Reservoirs, Interstitial water, Lysimeters, Sampling, Underground storage, Tensiometers.

A review of available technologies for monitoring leaks from underground storage tanks and surface impoundments was performed to identify equipment that was most suited for this purpose. A single probe that combines the functions of a tensiometer and lysimeter was selected for additional research based upon this review. The unit detects changes in matrix potential when functioning as a tensiometer and can also collect soil pore-water samples as a lysimeter. The probe developed from this effort was instrumented for both manual or remote monitoring, recording, and sampling. Instrumentation for automated maintenance allowed the unit to operate for extended periods of time without refilling the tensiometer mode of the probe with liquid. Probe density depends upon soil texture and moisture content, geometry of the containment structure, and depth of installation. Calculations for determining the optimum probe placement based upon the diameter of the porous ceramic portion along with soil dispersion characteristics determine the primary variables for determining the optimum number of probes for a given containment structure. Probe sensitivity is controlled by the porous surface to vessel liquid volume, the radius of the porous section, and type of surface instrumentation. (See also W89-01634) (Author's abstract)
W89-01654

PRACTICES FOR SAMPLING SOLID WASTES FROM POINT DISCHARGES AND IMPOUNDMENTS,
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 7A.
W89-01655

ASTM STANDARD LEACH TEST D3986: A HISTORY,
U.S. Pollution Control, Inc., Oklahoma City, OK.
K. Jackson.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 367-374, 4 tab.

Descriptors: *Standards, *Leaching, *Testing procedures, *Hazardous wastes, Sampling, Leachates, Waste characteristics, Waste disposal, American Society for Testing and Materials.

In 1977 American Society for Testing and Materials Subcommittee D19.12 (currently ASTM Committee D-34 on Waste Disposal) was organized to develop standard test methods for the evaluation of hazardous waste. A standard leach test was the first test that needed to be identified. The development of this standard leach test involved a two phase testing program. The phase one program identified the areas in the proposed test method that were responsible for the very high variability found during the testing program. The second phase testing program was designed and carried out to address those areas of variability. The proposed test method was adopted as a standard in June 1980. (See also W89-01634) (Author's abstract)
W89-01656

BATCH TYPE 24-H DISTRIBUTION RATIO FOR CONTAMINANT ADSORPTION BY SOIL MATERIALS,
Illinois State Geological Survey Div., Champaign. Geochemistry Section.
For primary bibliographic entry see Field 7B.
W89-01658

ABSORPTION OF HALOGENATED ORGANIC COMPOUNDS BY POLYMER MATERIALS COMMONLY USED IN GROUND WATER MONITORS,
Gartner Lee Associates Ltd., Markham (Ontario).
G. W. Reynolds, and R. W. Gillham.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 125-132, 5 fig, 1 tab, 17 ref.

Descriptors: *Organic compounds, *Sampling, *Sample contamination, *Chlorinated hydrocarbons, *Monitoring, *Wells, *Water sampling, Trichloroethane, Tetrachloroethane, Hexachloroethane, Bromoform, Tetrachloroethylene, Groundwater pollution, Contamination, Polyvinyl chloride, Polytetrafluoroethylene, Nylon, Polypropylene, Polyethylene, Latex rubber, Absorption.

Laboratory studies were conducted to determine the adsorption of 5 halogenated compounds, at parts per billion concentrations, by 6 polymer materials commonly used in ground water monitor construction. The batch experiments were carried out under static conditions to simulate water standing in a well bore. Measurements were made over the range of 5 minutes to 5 weeks. The organic compounds used were 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, hexachloroethane, bromoform and tetrachloroethylene. The polymer materials evaluated were PVC, polytetrafluoroethylene (PTFE), nylon, polypropylene, polyethylene and latex rubber. Uptake by the polymer materials can be explained by a model where the organic compound first undergoes sorption/dissolution into the polymer surface followed by diffusion into the polymer matrix. PVC and PTFE both absorbed 4 of the 5 compounds. However, absorption was generally slow for both of these materials with decreases in solution concentration <50% after 5 weeks. An exception was the rapid absorption of tetrachloroethylene by PTFE. The compound was reduced to 50% of its original concentration in solution in about 8 hours. The other polymers rapidly absorbed all compounds, with latex rubber having the most rapid absorption followed by polyethylene and then polypropylene and nylon. The order in which compounds were absorbed was different for each polymer. No relationship was found between the order or rate of absorption onto any polymer and the solubility or octanol/water partition coefficient of the organic compound. However, hexachloroethane and tetrachloroethylene, with solubilities one or two orders of magnitude less than the other compounds, were always absorbed the fastest and to the greatest extent. A relationship was found for polyethylene and polypropylene of increased absorption with an increase in the compound's undecane/water partitioning coefficient. (See also W89-01661) (Author's abstract)
W89-01674

SOIL VAPOR MONITORING AS A COST-EFFECTIVE METHOD OF ASSESSING GROUND WATER DEGRADATION FROM VOLATILE CHLORINATED HYDROCARBONS IN AN ALLUVIAL ENVIRONMENT,
Kleinfelder (J.H.) and Associates, Walnut Creek, CA.
G. R. Reid, G. Thompson, and C. Oberholtzer.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 133-140, 5 fig, 5 tab, 6 ref.

Descriptors: *Groundwater pollution, *Contamination, *Alluvial aquifers, *Pollutant identification, *Sampling, *Organic compounds, *Chlorinated hydrocarbons, *Soil vapor, *Water quality, *Monitoring wells, Path of pollutants, Trichloroethylene, Dichloroethylene, Aquifers, Trichloroethane, Perchloroethylene, Economic aspects, Hazardous materials.

Soil vapor monitoring is an increasingly used method for characterizing the quality of shallow aquifers when contamination by volatile organic constituents is a concern. This paper describes the results of a soil vapor monitoring program performed to evaluate the area distribution of trichloroethylene, 1,2-cis-dichloroethylene, trichloroethane and perchloroethylene in recent alluvial deposits in the South San Francisco Bay Region. Shallow ground water during this investigation was encountered at approximately 10 feet below grade, which afforded an opportunity to collect and compare both soil vapor and water quality data at approximately 50 discrete locations. Soil vapor/water correlation coefficients are presented for all 4 chlorinated hydrocarbons and indicate that vapor monitoring data can be used to (1) make a preliminary assessment of ground water quality degradation from volatile organic compounds and (2) optimize the design of a monitoring well network. The findings suggest that vapor monitoring networks located under asphalt and cement surfaces will provide more sensitive and reliable indications of shallow aquifer ground water quality. (See also W89-01661) (Author's abstract)
W89-01675

PRACTICAL METHODOLOGY FOR PROCESSING AND VALIDATION OF WATER QUALITY DATA,
Hydrometrics, Inc., Helena, MT.
For primary bibliographic entry see Field 7B.
W89-01684

ASSESSING THE BIOACCUMULATION OF CONTAMINANTS FROM SEDIMENTS BY FISH AND OTHER AQUATIC ORGANISMS,
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
W. A. Wilford, M. J. Mac, and R. J. Hesselberg.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 107-111, 1 fig, 8 ref.

Descriptors: *Bioaccumulation, *Path of pollutants, *Sediments, *Fish, Tissue analysis, Toxicity, Decision making, Ecological effects.

Contaminated sediments that are not acutely toxic to aquatic organisms but contain bioaccumulable toxic substances present a common, yet poorly understood problem for regulatory decision makers. In order to recommend options to minimize bioaccumulation of these toxic substances, decision-makers need estimates of: (1) which substances are available for accumulation by aquatic organisms; and (2) the potential impacts of such accumulation. The most direct and meaningful approach to estimating bioavailability is measurement of contaminant uptake by aquatic organisms exposed to the sediments of concern. Reasonably reliable methodologies exist for performing such exposures in the laboratory and in situ using marine or freshwater organisms. Such methods can demonstrate short-term potential for bioaccumulation of toxics from the sediments, but not necessarily the biological significance or long-term impact of any accumulated residues in the organisms and transfer of those residues through the food chain. Since most contaminated sediments contain a mixture of toxic substances, determination of the biological significance of their accumulation is not likely in the near future. Thus, the direct measurement of significant bioaccumulation of toxic substances from the sediments remains the most immediately useful index in a decision-making process. (See also W89-01714) (Author's abstract)
W89-01724

UNDERGROUND STORAGE SYSTEMS: LEAK DETECTION AND MONITORING,
Groundwater Technology, Inc., Annapolis Junction, MD.
T. G. Schwendeman, and H. K. Wilcox.
Lewis Publishers, Inc., Chelsea, Michigan. 1987. 213p.

Descriptors: *Monitoring, *Water pollution sources, *Underground storage, *Leakage, Gages, Electronic equipment, Waste storage, Hazardous wastes, Interstitial water.

During the past few years, there has been an explosive growth of methods to detect and monitor for leaks from underground storage tanks. During the past five to six years, more devices and methods have been developed for monitoring underground storage tanks than were developed in the previous 50 years. This book is designed to acquaint underground storage tank owners and operators with the many techniques and devices available today for monitoring underground storage tanks, i.e.: (1) automatic tank gaging devices; (2) automatic leak detectors; (3) vapor monitoring systems; and (4) interstitial monitoring. The authors have devoted a chapter to the testing and monitoring of the piping systems associated with underground tanks. It is important to distinguish monitoring systems from tank testing procedures, since both have a definite role to play in the proper management of underground tanks. Monitoring techniques provide a means to continuously or semicontinuously determine whether a system is leaking, whereas tank testing provides a means for determining at the time of the test whether a leak is occurring. The authors point out that the accuracy of existing tank testing procedures is limited by many variables. (Lantz-PTT)
W89-01765

INTERCALIBRATION OF ANALYTICAL METHODS ON MARINE ENVIRONMENTAL SAMPLES. RESULTS OF MEDPOL-II EXERCISE FOR THE INTERCALIBRATION OF CHLORINATED HYDROCARBON MEASUREMENTS ON MUSSEL HOMOGENATE (MA-M-2/OC).
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-702278. Price codes: A02 in paper copy, A01 in microfiche. International Atomic Energy Agency Report No. IAEA/RL/136, Report No. 29, October 1986. 12p, 4 tab, 4 ref, append.

Descriptors: *Chlorinated hydrocarbons, *Biological magnification, *Bioindicators, *Marine environment, *Pollutant identification, *Tissue analysis, *Mussels, Biological studies, Bioaccumulation, Calibration, Chemical analysis, Hydrocarbons, Chlorinated compounds, Seawater.

Mollusks are known to be able to concentrate micropollutants (e.g. chlorinated hydrocarbons) in their tissues from the surrounding seawater. when animals of the same species are living in the same conditions, the average concentration of a contaminant determined in their tissues after a sufficiently long exposure time should reflect the mean concentration of this substance in their environment. On the other hand, chlorinated hydrocarbons are normally present in seawater at very low concentration levels and it is much easier and less expensive to determine them in biological tissues than directly in seawater. Mussels, in particular, have been considered as good indicators of chlorinated hydrocarbon pollution of the marine environment and this led to the development of mussel watch programs in many countries in the late seventies. The present study had two goals: (1) to give to laboratories dealing with chlorinated hydrocarbon analyses of mussel tissues an opportunity to check their analytical performance; and (2) to make available a reference made of mussel tissue with robust estimations of the 'true values' with respect to several chlorinated hydrocarbons. Such material would allow chemists to check the validity of new analytical procedures. (Lantz-PTT)
W89-01780

COMMUNITY TOXICITY TESTING.
For primary bibliographic entry see Field 5C.
W89-01783

SOME METHODS FOR MEASURING EFFECTS OF TOXICANTS ON LABORATORY- AND FIELD-COLONIZED ESTUARINE BENTHIC COMMUNITIES,
Environmental Research Lab., Gulf Breeze, FL.
For primary bibliographic entry see Field 5C.
W89-01785

PRELIMINARY RESULTS OF INTERLABORATORY TESTING OF A STANDARDIZED AQUATIC MICROCOSM,
Washington Univ., Seattle. Coll. of Ocean and Fishery Sciences.
F. B. Taub, A. C. Kindig, and L. L. Conquest.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 93-120, 1 fig, 3 tab, 39 ref.

Descriptors: *Water pollution effects, *Aquatic environment, *Toxicity, *Standard methods, *Microcosms, *Copper sulfate, Algae, Biomass, Statistical studies, Bioassay, Comparison studies, Models, Nitrates, Performance evaluation, Daphnia.

Four standardized aquatic microcosm (SAM) experiments were performed at two laboratories to test the reproducibility of controls and copper sulfate treatments. Each laboratory (University of Washington and Duluth-EPA) conducted two 63-day experiments consisting of six replicates each of 0 (control), 500, 1000, and 2000 micrograms/L nominal copper (24 microcosms total). In controls, nitrate was rapidly converted to algal biomass and subsequently to Daphnia. Increasing amounts of copper delayed this conversion. At 500 micrograms/L Cu, algal blooms consistently occurred during the absence of Daphnia. Slightly different amounts of initial copper were related to the duration of these delays. Recovery of the microcosm communities was made possible by detoxification of copper through precipitation, chelation, and sorption, as predicted by the MINEQL copper speciation model. Statistical evaluation of results within each experiment was displayed by an 'interval of nonsignificant difference' around the control means. A procedure to statistically compare experiments for reproducibility is being developed, based upon discriminant analysis of distance measures between control and treatment microcosms. Results from this statistical procedure are presented for the four experiments on three variables (nitrate, Daphnia, algal biovolume). Statistical analyses support the hypothesis that these moderately complex ecological experiments are more similar within laboratories than between laboratories. In spite of this, the conclusions reached from both sets of experiments are similar. (See also W89-01783) (Author's abstract)
W89-01788

MICROCOSM PROCEDURE FOR DETERMINING SAFE LEVELS OF CHEMICAL EXPOSURE IN SHALLOW-WATER COMMUNITIES,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5C.
W89-01789

COMPARISON OF MIXED FLASK CULTURE AND STANDARDIZED LABORATORY MODEL ECOSYSTEMS FOR TOXICITY TESTING,
Minnesota Univ.-Duluth. Dept. of Biology.
L. J. Shannon, M. C. Harrass, J. D. Yount, and C. T. Walbridge.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 135-157, 5 fig, 4 tab, 29 ref. EPA Contract CR810741-01.

Descriptors: *Toxicity, *Standard methods, *Copper, *Water pollution effects, *Ecosystems, Model studies, Comparison studies, Microcosms.

Two microecosystem protocols, the standardized aquatic microcosm (SAM) method and the mixed flask culture (MFC) method, were compared on the basis of their responses to copper sulfate. These protocols differed in microcosm structure, age, and the variables monitored. Two complete experiments were conducted with each method so that repeatability, as well as sensitivity and variability, could be evaluated. Copper caused significant reductions in pH, oxygen gain, and oxygen loss at concentrations down to 500 micrograms/L (the lowest test concentration) in the SAM tests and 320 micrograms/L in the MFC tests. Lower copper concentrations (36 and 70 micrograms/L) in the MFC tests caused significant increases over control levels for several system-level variables. Although responses were similar with both systems, the SAM procedure provided considerably more insight into the changes in population densities and nutrient cycling responsible for the observed ecosystem level changes. The SAM systems, on the basis of their higher coefficients of variation (CV) and higher minimum detectable differences (MDD), appeared to be theoretically less able to demonstrate significant toxic effects. The SAM results were more consistent, with microcosms developing and responding to copper in a similar manner in both runs. In contrast, the microcosms in the MFC experiments showed major differences in both development and sensi-

tivity between runs. (See also W89-01783) (Lantz-PTT)
W89-01790

EVALUATION OF SIMPLE GENERIC AQUATIC ECOSYSTEM TESTS TO SCREEN THE ECOLOGICAL IMPACTS OF PESTICIDES,
Aqua Terra Technologies, Pleasant Hill, CA.
For primary bibliographic entry see Field 5C.
W89-01791

POPULATION AND GUILD ANALYSIS FOR INTERPRETATION OF HEAVY METAL POLLUTION IN STREAMS,
Lund Univ. (Sweden). Limnological Inst.
For primary bibliographic entry see Field 5C.
W89-01792

EFFECT OF 3-TRIFLUOROMETHYL-4-NITROPHENOL ON THE STRUCTURE AND FUNCTION OF PROTOZOAN COMMUNITIES ESTABLISHED ON ARTIFICIAL SUBSTRATES,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
P. V. McCormick, J. R. Pratt, and J. Cairns.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 224-240, 8 fig, 1 tab, 29 ref.

Descriptors: *Trifluoromethyl nitrophenol, *Water pollution effects, *Nitrophenols, *Bioassay, *Ecological effects, *Protozoa, Toxicity, Artificial substrates, Biological studies, Lethal limits.

The development of community level toxicity protocols would allow for the direct determination of toxicant effects on community level processes. Using protozoan communities colonized on artificial substrates for testing the effects of hazardous substances allows rapid testing in a minimal amount of space. These communities were used in: (1) 48-h acute tests; (2) a 28-day static test; and (3) 10-day continuous flow tests to assess the usefulness of structural and functional indices in determining adverse effects of the lamprey larvicide 3-trifluoromethyl-4-nitrophenol (TFM). Acute tests used protozoan communities of differing ages and were relatively insensitive to the toxicant; the EC sub 50 was 48.0 ppm. Continuous flow tests had high variability in colonization within treatments, and no significant concentration differences were detected. Functional group analyses showed no effect on community function, although higher trophic levels were reduced or absent at 10 ppm. Results support the use of multispecies tests in determining toxic effects on natural communities, while showing the need for continued work in this area to develop standardized, replicable testing procedures. (See also W89-01783) (Author's abstract)
W89-01795

USE OF LIMNOCORRALS IN EVALUATING THE EFFECTS OF PESTICIDES ON ZOOPLANKTON COMMUNITIES,
Guelph Univ. (Ontario). Dept. of Environmental Biology.
For primary bibliographic entry see Field 5C.
W89-01797

ZOOPLANKTON COMMUNITY RESPONSES TO SYNTHETIC OIL EXPOSURE,
Science Applications International Corp., Oak Ridge, TN.
For primary bibliographic entry see Field 5C.
W89-01798

PRODUCTION OF COEXISTING JUVENILE COHO SALMON AND STEELHEAD TROUT IN HEATED MODEL STREAM COMMUNITIES,
Northrop Services, Inc., Corvallis, OR.
For primary bibliographic entry see Field 5C.
W89-01799

INTERCALIBRATION OF ANALYTICAL ETHODS ON MARINE ENVIRONMENTAL SAMPLES: RESULTS OF MEDPOL II EXERCISE FOR THE INTERCOMPARISON OF TRACE ELEMENT MEASUREMENTS ON MUSSEL TISSUE HOMOGENATE AND MARINE SEDIMENT (MA-M-2/TM AND SD-N-1/2/TM).
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-702279. Price codes: A03 in paper copy, A01 in microfiche. Report No. IAEA/RL/137 Monaco/31, December 1986. 41p, 32 tab, 4 ref.

Descriptors: *Mussels, *Tissue analysis, *Pollutant identification, *Marine sediments, *Bioindicators, Heavy metals, Statistical studies, Sediment contamination.

Filter-feeding animals (e.g. mussels) and coastal sediments are often considered as contamination indicators of the marine environment. Mussels react quickly to the pollution of the surrounding seawater, while mechanisms of transfer and fixation of heavy metals into sediments often reflect long-term processes. Many scientists, therefore, who study the contamination of the Mediterranean Sea are faced with problems of analysis of heavy metals in mussels and sediments. Since these analyses are often very difficult and require elaborate techniques, it was judged appropriate to provide the analysts working in institutes participating in MEDPOL Phase II with an opportunity for checking their analytical performances. The within-laboratory precision was shown to be satisfactory. For the mussel MA-M-2/TM, 65% of the reported coefficients of variation lie between 0 and 10%, 25% are between 10 and 20%, 9% between 20 and 30%, and only 1% higher than 30%. In the case of the sediment SD-N-1/2/TM, 90% of the reported coefficients of variation lie between 0 and 10% and the remaining 10% are between 10 and 20%. The total number of outliers is moderate (9.2% of all results in the case of MA-M-2/TM and 2.0% in the case of SD-N-1/2/TM). The number of outlying results by participating laboratory varied between 0 and 4. Five laboratories produced 1 outlier, two laboratories reported 2 outliers and one laboratory produced 4 outliers (for 11 reported results). (Lantz-PTT)
W89-01813

ASTM STANDARDS ON MATERIALS AND ENVIRONMENTAL MICROBIOLOGY.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 2H.
W89-01826

AQUATIC TOXICOLOGY AND ENVIRONMENTAL FATE: NINTH VOLUME.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 5B.
W89-01892

TOWARD A MEANINGFUL INTERACTION BETWEEN ECOLOGY AND AQUATIC TOXICOLOGY,
Utah State Univ., Logan.
For primary bibliographic entry see Field 5C.
W89-01894

CAN BIOLOGICAL MONITORING EARLY WARNING SYSTEMS BE USEFUL IN DETECTING TOXIC MATERIALS IN WATER,
Army Medical Bioengineering Research and Development Lab., Fort Detrick, MD. Health Effects Research Div.
W. H. Van der Schalie.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 107-121, 2 fig, 6 tab, 36 ref.

Descriptors: *Toxicology, *Pollutant identification, *Aquatic toxicology, *Monitoring, Water quality control, Biological studies, Bioassay, Water pollution effects, Toxicity, Water pollution prevention.

Biological monitoring early warning systems continuously and automatically monitor the physiological or behavioral responses of aquatic organisms exposed under flow-through conditions to surface water or wastewater and provide an immediate indication of abnormal organism responses. Such systems have several advantages over physicochemical sensors, and their use has been suggested for the protection of both aquatic organisms and humans from water-borne toxicants. A literature search identified 16 biological monitoring early warning systems that have been used for monitoring toxicity under field conditions, and their usefulness in reliably detecting toxic materials in water was determined. Biomonitors are best suited for detecting materials that are acutely toxic to aquatic organisms; the systems have less potential for monitoring concentrations of materials that are chronically toxic to aquatic organisms or that pose a human health hazard. Biological monitoring early warning systems can complement, but not replace, existing physico-chemical water quality monitors. (See also W89-01892) (Author's abstract)
W89-01901

USE OF HELIOPHRYA SP., A SESSILE SUCTORIAN PROTOZOAN, AS A BIOMONITOR OF URBAN RUNOFF,
Georgetown Univ., Washington, DC. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W89-01903

FIELD AND LABORATORY TOXICITY TESTS WITH SHRIMP, MYSIDS, AND SHEEPSHEAD MINNOWS EXPOSED TO FENTHION,
Environmental Research Lab., Gulf Breeze, FL.
For primary bibliographic entry see Field 5C.
W89-01905

PASSIVE PERCHORIONIC CARCINOGEN BIOASSAY USING RAINBOW TROUT (SALMO GAIRDNERI) EMBRYOS,
Roswell Park Memorial Inst., Buffalo, NY. Dept. of Experimental Biology.
A. E. Maccubbin, and J. J. Black.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 277-286, 4 fig, 3 tab, 11 ref. EPA Grant CR811689-01, American Cancer Society Institutional Grant IN-54W, and NIH Research Grant Ca 16056.

Descriptors: *Toxicology, *Water pollution effects, *Rainbow trout, *Bioassay, *Embryos, *Aquatic toxicology, *Carcinogenicity, Organic compounds, Toxicity, Liver, Bioaccumulation, Fish physiology.

A noninvasive method for exposing eyed-stage rainbow trout (Salmo gairdneri) embryos to chemicals in a bioassay for toxicity and carcinogenicity was tested with four known mammalian carcinogens. Aflatoxin B sub 1 (AFB sub 1), benzo(a)pyrene (BaP), dimethylnitrosamine (DMN), and N-methyl-N'-nitro-N-nitrosoguanidine (MNNG) were applied topically in dimethyl sulfoxide (DMSO) to the chorion of developing rainbow trout embryos. All chemicals were toxic and decreased viability of fry after hatching. In addition, AFB sub 1 (90 nanograms/egg) increased mortality in the egg stage and was the most toxic chemical tested. After a latent period of eight months, all chemicals had induced liver neoplasms in surviving fingerlings. The incidence of liver neoplasia ranged from 4.8% for DMN at 170.7 micrograms/egg to 76.9% for MNNG at 20.5 micrograms/egg and generally was in the form of basophilic foci of altered hepatocytes. Eleven months post exposure, all treatment groups had

individuals with well-differentiated heptocellular carcinomas. The data suggest that the method has the potential to be a useful bioassay for chemical carcinogenicity. (See also W89-01892) (Author's abstract)
W89-01914

VALIDATION OF COLLABORATIVE TESTING GUIDELINES,
Environmental Protection Agency, Las Vegas, NV. Quality Assurance Div.
L. R. Williams, D. R. Meckley, and G. E. Schiefer.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 335-348. EPA Contract 68-03-3136.

Descriptors: *Aquatic toxicology, *Toxicology, *Standards, *Biological studies, *Quality control, *Bioassay, Daphnia, Toxicity.

The effectiveness of collaborative testing guidelines was evaluated in two multi-laboratory method-validation studies conducted for the EPA. The guidelines were developed for EPA's Office of Toxic Substances and modeled after those of the Association of Official Analytical Chemists and The American Society for Testing and Materials. They were applied, to a greater or lesser extent, in the conduct of validation studies of the EPA's interim Ames test mutagenicity assay and Daphnia magna life-cycle toxicity assay. At the conclusion of the testing phase of the studies, each participant was requested to provide information related to key guideline elements. In addition, the organizers of each study indicated the degree to which they followed or did not follow the guidelines in administering their studies. Both participants and organizers were urged to provide recommendations for improving the way in which such studies are conducted in the future. The results are the basis for validation and appropriate revision of the collaborative testing guidelines. Results are presented and the implication of those results for future collaborative studies are discussed. (See also W89-01892) (Author's abstract)
W89-01917

WHY ROUND-ROBIN TESTING WITH ZOOPLANKTON OFTEN FAILS TO PROVIDE ACCEPTABLE RESULTS,
Dow Chemical U.S.A., Midland, MI. Dept. of Environmental Quality.
U. M. Cowgill.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 349-356, 34 ref.

Descriptors: *Toxicology, *Quality control, *Zooplankton, *Round-robin testing, *Aquatic toxicology, Toxicity, Biological studies, Bioassay, Chemical properties, Bioindicators.

Critical variables are discussed that occur in the culture and testing of Cladocerans that are responsible for the failure to obtain acceptable results in interlaboratory comparisons. The variables in question include diet, ambient medium, health of the test species, characteristics and purity of the compounds tested, and finally, whether nominal or measured concentrations are utilized to estimate the results of static acute toxicity tests. Available data indicate that diet, ambient medium, health of the test organisms, and the physical and chemical characteristics of the test compound and how the latter is measured seriously affects the comparability of the results of round-robin tests. Some recommendations are offered that might improve results from interlaboratory studies. These include procedures to be instituted to ascertain the health of the test organism. In addition, careful consideration should be accorded the selection of test compounds. Test compounds that are nontoxic or slightly toxic, have a high solubility in water, are of low molecular weight, have a low boiling point, a high vapor pressure, and few chlorine atoms within their structure will provide better precision than those compounds that have characteristics distinct from those just mentioned. In addition, measured test concentrations will improve interlaboratory comparisons over results obtained with nominal test concentrations. (See also W89-01892) (Author's abstract)
W89-01918

FACTORS AFFECTING THE CULTURE OF DAPHNIA MAGNA,
Unilever Research Port Sunlight Lab., Bebington (England).
C. M. Lee, C. A. Turner, and E. Huntington.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 357-368, 9 tab, 17 ref.

Descriptors: *Aquatic toxicology, *Toxicology, *Daphnia, *Bioassay, *Culturing techniques, Light intensity, Water pollution effects, Chlorella vulgaris, Food, Yeast, Microbiological studies.

A factorial design was used to determine the individual and combined effects of light intensity, photoperiod, temperature, food, and feeding regime on the survival and production of Daphnia magna. Changes in light intensity between 150 and 1000 lx, in photoperiod between 16 and 24 h, and in temperature between 18 and 23 C will not affect survival. There is however a strong light times temperature times food interaction that can influence juvenile production. Using a higher light intensity when the food level was low improved productivity. The individual effects of increasing temperature and photoperiod were trivial. Low juvenile production was found when a low food level of 150,000 cells/ml Chlorella vulgaris was coupled with a low light intensity of 150 lx and a temperature of 23 C. Feeding C. vulgaris grown in vitamin-enriched medium improved juvenile production only when the food level was high and appeared to have a negative effect when food quantity was inadequate. Food was provided as C. vulgaris alone or mixed with yeast cells and at various cell numbers of both. Juvenile production that would meet current criteria for 21-day life cycle tests was achieved with 750,000 cells/ml vitamin-enriched C. vulgaris both with and without yeast at 1,500,000 to 2,500,000 cells/ml under a light intensity of 1000 lx and a photoperiod of 16 h at 18 C. (See also W89-01892) (Author's abstract)
W89-01919

QUALITY ASSURANCE REVIEW OF THE USE OF THE HYDRA ASSAY IN DEVELOPMENTAL TOXICITY (TERATOLOGY) STUDIES,
Argus Research Labs., Inc., Horsham, PA.
For primary bibliographic entry see Field 5C.
W89-01921

USE OF HEXAVALENT CHROMIUM AS A REFERENCE TOXICANT IN AQUATIC TOXICITY TESTS,
North Texas State Univ., Denton. Dept. of Biological Sciences.
K. M. Jop, J. H. Rodgers, P. B. Dorn, and K. L. Dickson.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 390-403, 4 fig, 3 tab, 29 ref.

Descriptors: *Pollutant identification, *Toxicology, *Chromium, *Aquatic toxicology, *Toxicity, Bioassay, Daphnia, Organisms, Lethal limits.

The suitability of hexavalent chromium (Cr) as a reference toxicant was examined in 39 toxicity tests using six species of aquatic organisms. In 19 tests conducted during a one and one-half year period with Daphnia pulex from a laboratory culture, the mean 48-h EC sub 50 was 0.129 mg Cr/L, with a range of 0.07 to 0.19 mg/L. The least sensitive animal tested was lepomis macrochirus, with a mean 96-h LC sub 50 of 191.9 mg Cr/L. Daphnia pulex was the most sensitive species followed by the saltwater species Mysidopsis bahia and Cyprinodon variegatus. Slopes of chromium concentration versus mortality ranged from 357 for D. pulex to 0.3 L. macrochirus, while Pimephales promelas, C. variegatus, and Gasterosteus aculeatus had similar 96-h LC sub 50s (23.2 to 42.6 mg Cr/L) and similar concentration-mortality plot slopes (0.9 to 1.1). Comparing the health of the D. pulex population through time by the EC sub 50 values revealed that while the organisms may exhibit similar EC sub 50 values and a low coefficient of variation (CV) of 26%, concentration-mortality curve slopes varied between 285 and 422. This suggests that slopes of the concentration-mortality curves with the same EC sub 50 value can serve as a sensitive measure of organism health through time. As a reference toxicant, hexavalent chromium provides a useful benchmark for assessing the health of toxicity test organisms through time. (See also W89-01892) (Author's abstract)
W89-01922

APPLICABILITY OF USING A SINGLE LABORATORY EVALUATION TO SELECT CANDIDATES FOR COLLABORATIVE TESTING: EXPERIENCE WITH A SOIL TOXICITY BIOASSAY,
North Texas State Univ., Denton. Dept. of Biological Sciences.
R. D. Rogers, and P. A. Pryfogle.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 404-412, 5 tab, 10 ref. EPA Contract DW930077-01-1.

Descriptors: *Toxicology, *Bioassay, *Standards, *Soil toxicity, *Quality control, *Aquatic toxicology, Monitoring.

The purpose of a single laboratory evaluation is to provide a rational basis for deciding whether or not a bioassay merits the effort and expense of the collaborative testing necessary to qualify it for inclusion as part of an operational monitoring network. Guidelines, published by the U.S. EPA state that a single laboratory test should evaluate a proposed method's capability for ruggedness, sensitivity, limits or reliable measurement, systematic error, precision, and accuracy. To demonstrate the use of these guidelines, the Hydrogen Oxidation Soil Bioassay was selected for evaluation as a potential candidate for collaborative testing. Results from this demonstration indicated that the single laboratory evaluation provides a concise and organized approach for selecting bioassays for collaborative testing. (See also W89-01892) (Author's abstract)
W89-01923

BEHAVIORAL AND MORPHOLOGICAL CHANGES IN FATHEAD MINNOW (PIMEPHALES PROMELAS) AS DIAGNOSTIC ENDPOINTS FOR SCREENING CHEMICALS ACCORDING TO MODE OF ACTION,
Environmental Research Lab.-Duluth, MN.
For primary bibliographic entry see Field 5C.
W89-01924

EFFECT OF NATURAL WATER SOURCE ON THE TOXICITY OF CHEMICALS TO AQUATIC MICROORGANISMS,
Smith Kline and French Labs., King of Prussia, PA.
V. L. Cunningham, M. S. Morgan, and R. E. Hannah.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 436-449, 8 fig, 4 tab, 14 ref.

Descriptors: *Water pollution effects, *Aquatic toxicology, *Bioassay, *Organic compounds,

*Toxicology, Toxicity, Chlorophenol, Organic carbon, Bacteria, Water pollution sources, Humic acids, Chemical analysis, Bioluminescence, Gas chromatography, Mass spectrometry.

A series of substituted chlorophenols was evaluated in the Beckman Microtox Analyzer using natural water from several diverse sources. Statistically significant differences in the effect level, as measured by an ANOVA of the EC sub 50 (the concentration of toxicant that causes a 50% reduction in the light output of the bioluminescent bioassay organism, Photobacterium phosphoreum), were observed as a function of water source for three of the four compounds tested. These differences may be attributed to differences in the nature and concentration of natural dissolved organic carbon (DOC) in the water samples. Some DOC, such as humics, are suspected of binding hydrophobic toxicants, and thus reducing the bioavailability and toxic effect of these compounds. At least one of the observed toxicity reductions can be accounted for by specific compound characteristics and the nature and concentration of the DOC as determined by fluorescence spectroscopy and fingerprinting by pyrolytic gas chromatography/mass spectrometry (GC/MS) techniques. However, for the other compounds tested, fluorescence techniques provide inadequate. Additional methodology will be necessary to elucidate the seemingly more complex mechanisms of toxicity reduction for these compounds. (See also W89-01892) (Author's abstract)
W89-01925

EFFECTS OF DIET QUANTITY ON SHEEPSHEAD MINNOWS (CYPRINODON VARIEGATUS) DURING EARLY LIFE-STAGE EXPOSURES TO CHLORPYRIFOS,
Environmental Research Lab., Gulf Breeze, FL.
For primary bibliographic entry see Field 5C.
W89-01926

METHODOLOGY FOR DETERMINING THE RELATIONSHIP BETWEEN TOXICITY AND THE AQUEOUS SPECIATION OF A METAL,
Battelle Pacific Northwest Labs., Richland, WA.
C. E. Cowan, E. A. Jenne, and R. R. Kinnison.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 463-478, 2 fig, 4 tab, 26 ref. DOE Contract DE-AC06-76RLO 1830.

Descriptors: *Pollutant identification, *Toxicology, *Toxicity, *Metals, *Chemical properties, *Aquatic toxicology, Model studies, Water pollution effects, Copper, Chemical composition.

Over the last decade, numerous investigators have tried to determine the link between the aqueous speciation of a metal and the metal's toxicity to aquatic organisms. The high collinearity between the calculated activities of the aqueous chemical species as well as the underdetermined nature of many of the toxicity data sets have made identification of particular toxic species for a metal very difficult and quantification virtually impossible. The author's suggested, in a recent paper, an approach for determining the toxic chemical species of a metal and for determining and quantifying the relationship between a toxicity measure and the chemical speciation of a metal. Briefly, the approach consists of first computing the aqueous speciation of the metal using the geochemical model, MINTEQ, with a thoroughly reviewed and partially-validated thermodynamic data base. Finally, advanced statistical methods, which were determined to be stable when applied to collinear data and underdetermined systems, are applied to the thermodynamic activities of the metal species and toxicity measures to determine and quantify the relationship between the speciation and toxicity. To test the validity of this methodology, this study applied it to four copper toxicity data sets from the literature for which the primary toxic species have been tentatively identified by the original authors using qualitative techniques. The results of applying the methodology to these studies indicate that the primary toxic chemical species are the free copper ion and the hydroxide species and that the carbonate species are nontoxic. These findings largely confirm the results of previous qualitative analyses of the copper toxicity literature. (See also W89-01892) (Lantz-PTT)
W89-01927

METHODOLOGY FOR ASSESSING THE ACUTE TOXICITY OF CHEMICALS SORBED TO SEDIMENTS: TESTING THE EQUILIBRIUM PARTITIONING THEORY,
Monsanto Environmental Sciences Center, St. Louis, MO.
P. S. Ziegenfuss, W. J. Renaudette, and W. J. Adams.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 479-493, 3 fig, 7 tab, 15 ref.

Descriptors: *Toxicity, *Organic compounds, *Sediment contamination, *Pollutant identification, *Toxicology, *Aquatic toxicology, Midges, Bioassay, Daphnia, Lethal limits, Organic carbon, Kepone.

A method was developed to assess the acute toxicity of neutral hydrophobic organic compounds sorbed on sediments to the midge, Chironomus tentans and the daphnid Daphnia magna. Three soils with different organic carbon content were spiked with 14-C labeled kepone, placed in 250 ml clear polycarbonate centrifuge bottles, mixed with dilution water at a 4:1 water to soil ratio, shaken for 24 h, centrifuged, and tested. Midges and daphnids (five each) were tested together in the same bottles. The 48-h LC sub 50 values were calculated for each species. The LC sub 50 values were calculated on the basis of the concentration of kepone on the sediment, the column water, and the sediment interstitial water. The data indicate that the route of exposure was the water and not the sediments per se. Midges were not found to have increased sensitivity in the presence of the sediment. The data support sediment-water equilibrium partitioning theory and the carbon normalization theory for neutral organic chemical sorbed to soils or sediments. The advantages of this test are that it is rapid, uses disposable test containers, employs two species simultaneously, incorporates sediment as part of the test system, is performed under steady-state conditions between sediment and water for he chemical(s) of interest, and is based upon sorption/desorption theory for neutral organic chemicals. Additional testing with other chemical classes will demonstrate the broad utility of this method as an acute screening test for naturally contaminated sediments as well as laboratory spiked sediments. (See also W89-01892) (Author's abstract)
W89-01928

COMPARISON OF LABORATORY AND FIELD METHODS FOR TESTING THE TOXICITY OF CHEMICALS SORBED TO SEDIMENTS,
Monsanto Environmental Sciences Center, St. Louis, MO.
W. J. Adams, P. S. Ziegenfuss, W. J. Renaudette, and R. G. Mosher.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 494-513, 2 fig, 9 tab, 22 ref.

Descriptors: *Sediment contamination, *Toxicity, *Organic compounds, *Pollutant identification, *Toxicology, *Saginaw River, *Aquatic toxicology, Bioassay, Pydraul 50E, Daphnia, Midges, Benthic environment.

Standard water exposure as well as sediment toxicity tests were performed in Monsanto laboratories and on-site at the Saginaw River in a mobile bioassay trailer to develop sediment toxicity tests and assess the hazard of Pydraul 50E (P50E) when sorbed to sediments. Sediment samples were collected from five river stations and tested in the field. Sediment concentrations of P50E, an aryl phosphate ester hydraulic fluid, were determined for each site. The site furthest upstream contained the lowest level and was used as a control site. Both acute and chronic tests were performed with the sediments and with control sediments spiked with P50E using the midge Chironomus tentans and the daphnids Daphnia magna and Ceriodaphnia affinis. The results indicate that field toxicity tests conducted with river sediments and river water agreed within a factor of two with those obtained in the laboratory using spiked soils and well water. Acute sediment toxicity tests performed with C. tentans and D. magna together provided a rapid screen of the acute toxicity of Saginaw River sediments and P50E spiked on river sediments. Chronic sediment tests with Ceriodaphnia affinis provided a rapid sensitive measure of the toxicity of the Saginaw River sediments. Benthic species diversity in the Saginaw river and C. affinis reproduction in sediment toxicity tests were correlated ($r = 0.59$) and decreased as function of distance downstream from the control site. They did not correlate well with P50E ($r = -0.18$) concentrations that ranged from < 0.01 to 11.31 mg/kg. Margins of safety calculated for these sediment concentrations ranged from 13 to 39,000 indicating that the potential of this chemical to impact Saginaw River benthic organisms is low. (See also W89-01892) (Author's abstract)
W89-01929

AQUATIC TOXICOLOGY AND HAZARD ASSESSMENT: SEVENTH SYMPOSIUM.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 5C.
W89-01930

EVALUATION OF FILAMENTOUS ALGAE AS BIOMONITORS OF METAL ACCUMULATION IN SOFTWATER LAKES: A MULTIVARIATE APPROACH,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
R. C. Bailey, and P. M. Stokes.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 5-26, 6 fig, 11 tab, 24 ref.

Descriptors: *Algae, *Bioassay, *Heavy metals, *Water pollution effects, *Toxicology, *Aquatic toxicology, *Bioaccumulation, Multivariate analysis, Cadmium, Manganese, Aluminum, Copper, Nickel, Zinc, Phosphorus, Conductivity, Hydrogen ion concentration, Sediment contamination.

Algae from artificial substrates were collected from 36 softwater lakes in four geographic areas of central Canada. Determination of aluminum, manganese, cadmium, copper, nickel, lead, and zinc were made on the algae, water, and sediment. Sediment nutrients, water pH, alkalinity, and conductivity were also measured. One objective of the study was to evaluate algae as biomonitors of metals. Another was to determine the levels of metals in water and sediments as they related to other environmental variables. A multivariate approach was used to analyze the data statistically. As pH decreased, metal concentration in water and algae increased. Sediment metals were unrelated to water pH, but were positively related to sediment organic level and algal metals. Sediment metals were approximately X1000 the metal concentrations in water, whereas algal metals were 1000 to X10,000 greater than water levels. An evaluation was made of algae as biomonitors of acid-stressed lakes. Their role in metal cycling in aquatic systems is identified as an area for future research. (See also W89-01930) (Author's abstract)
W89-01931

CYANOPHAGE ASSAY AS A NEW CONCEPT IN THE STUDY OF ENVIRONMENTAL TOXICITY,
Algal Research Center, Landenberg, PA.
M. P. Kraus.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 27-41, 6 fig, 8 tab, 14 ref.

Descriptors: *Cyanophage, *Aquatic toxicology, *Environmental effects, *Toxicology, *Bioindicators, *Water quality, Toxicity, Viruses, Wastewater treatment, Monitoring, Formaldehyde, Actane, Pesticides, Organic compounds, Baytex, Diazanon, Lethal limits, Algae.

For more than 15 years, a virus-based assay using a cyanophage/host system has been a reliable indicator of water quality in fresh and saline water, in sewage and water treatment, and in various lagooned agricultural and industrial wastes. More recently, this host/virus model has been used in the study of toxic effects and their mechanisms of action. To comprehend specific effects at low doses better, toxicants are observed during the infectious cycle. The success of this approach depends on the genetic distinctions by which one host differs from another in its sensitivity to certain cyanophages. Five cyanophages and eight hosts constitute the currently used system. A host/virus system carries the analysis into the realm of molecular biology whose vast store of genetic information on similar systems can contribute to the biological characterization of the blue-green algal system. Data acquired on formaldehyde, the s-triazine Actane, and the organophosphate pesticides Baytex and diazinon, indicate that the interaction of low doses of toxicant during the infectious cycle need not be a simple function of dose and imply that an LD sub 50 (= median lethal dose) value, or the extrapolation of a laboratory-derived survival curve toward zero, may not be an accurate picture of environmental aquatic toxicity. In view of the current demand for in vitro screening methods, the economy and relative simplicity of the cyanophage approach is of considerable significance. (See also W89-01930) (Author's abstract)
W89-01932

DIETS FOR CERIODAPHNIA RETICULATA LIFE-CYCLE TESTS,
Environmental Research Lab.-Duluth, MN.
T. J. Norberg, and D. I. Mount.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 42-52, 7 fig, 1 tab, 15 ref.

Descriptors: *Life-cycle tests, *Ecological effects, *Daphnia, *Diets, *Bioindicators, *Toxicology, *Aquatic toxicology, Bioassay, Yeast, Population dynamics, Toxicity.

Two diets were compared for the cladoceran, Ceriodaphnia reticulata, for use in culturing and life-cycle toxicity tests. One diet was a suspension of dry yeast dissolved in distilled water and fed at a rate of 250 micrograms/animal. The other diet was prepared from frozen adult brine shrimp (Artemia salina) and distilled water, the aged supernatant of which was fed using 0.05 ml/animal. Animals were fed daily and water changed three times each week. The feeding study was conducted for ten generations using young per female and adult survival as endpoints. The young production per female of surviving adults was comparable, but the longevity of the animals fed the yeast diet was considerably greater than that of the animals fed the shrimp diet. (See also W89-01930) (Author's abstract)
W89-01933

EFFECT OF DIET ON THE SENSITIVITY OF DAPHNIA MAGNA TO LINEAR ALKYLBENZENE SULFONATE,
Procter and Gamble Co., Cincinnati, OH. Ivorydale Technical Center.
M. J. Taylor.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 53-72, 2 fig, 10 tab, 27 ref.

Descriptors: *Diets, *Daphnia, *Alkylbenzene sulfonate, *Ecological effects, *Toxicology, *Aquatic toxicology, Bioassay, Lethal limits, Algae, Trout, Toxicity, Detergents.

Laboratory cultures of Daphnia magna were maintained in hard well water and fed one of five different diets. Algal diets, trout chow diets, and diets combining algae and trout chow were evaluated. The acute toxicity (48-h LC sub 50) of C sub 11.8 LAS (linear alkylbenzene sulfonate) to D. magna reared on the five different diets ranged between 3.6 and 4.7 mg/L. For daphnids that were fed during the acute test, the LC sub 50s ranged between 4.4 and 8.1 mg/L LAS. The addition of food to the acute test generally increased the LC sub 50. Diet had a statistically significant effect on the sensitivity of D. magna to the chronic toxicity of LAS. Chronic no-observed effect concentrations (NOECs) varied about three-fold (1.2 to 3.2 mg/L) and 21-day LC sub 50s about two-fold (2.2 to 4.7 mg/L) for daphnids fed the five diets. Survival was generally the most sensitive indicator of chronic effects. Food concentration also had a significant effect on the response of D. magna to the chronic effects of LAS. Daphnia cultures receiving lower concentrations of food were less sensitive to LAS than Daphnia cultures receiving higher food concentrations. Diet had at most three-fold effect on the results of Daphnia toxicity tests. A three-fold variability can be expected in Daphnia toxicity tests themselves. Therefore, use of any of the diets in this study should not affect the utility of the test results in assessing the environmental effects of detergent chemicals such as LAS. (See also W89-01930) (Author's abstract)
W89-01934

STUDY OF THE RELIABILITY OF DAPHNIA ACUTE TOXICITY TESTS,
Environmental Monitoring and Support Lab.-Cincinnati, OH. Biological Methods Branch.
P. A. Lewis, and C. I. Weber.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 73-86, 1 fig, 4 tab, 29 ref.

Descriptors: *Toxicity, *Bioassay, *Daphnia, *Toxicology, *Aquatic toxicology, Performance evaluation, Sodium dodecyl sulfate, Detergents, Sodium pentachlorophenate, Cadmium, Hydrogen ion concentration, Lethal limits, Population dynamics.

Acute toxicity tests using Daphnia magna or D. pulex have been employed for many years to determine the toxicity of effluents and toxic substances. However, the many factors that may affect the results of such tests have received little attention. Sequential, repetitive tests were conducted with the reference toxicants sodium dodecyl sulfate (SDS), sodium pentachlorophenate (PCP), and cadmium (Cd) to determine the single laboratory precision of acute 48-h toxicity tests using D. magna and D. pulex, and the effects of feeding on toxicity. The sensitivity of Daphnia to pH shock was also examined. Control survival was 90% or better in 94% of the tests, and 80% or better in 89% of the tests. Survival of controls in tests where the organisms were fed was slightly higher than when they were not fed. The precision of the method, expressed as the relative standard deviation (percent coefficient of variation or CV) of the 48-h LC sub 50, for each reference toxicant, SDS, PCP, and Cd, was 43.8, 35.7, and 20.9% for D. pulex and 28.9, 10.4, and 72.4% for D. magna, respectively. No statistically significant differences ($P = 0.05$) were observed in 48-h LC sub 50 values obtained from paired tests with fed and unfed D. pulex exposed to PCP or Cd, or with D. magna exposed to SDS. However, the 48-h LC sub 50 values were significantly different for fed and unfed D. magna exposed to PCP or Cd. D. pulex and D. magna were equally sensitive to SDS and PCP, but D. magna was significantly more sensitive to Cd than D. pulex, even though D. magna was tested in water of much greater hardness. Sudden changes in pH of not more than two pH units in the range of pH 5 to 9 resulted in no mortality over a six-day period. (See also W89-01930) (Author's abstract)
W89-01935

SHORT-CUT CHRONIC TOXICITY ESTIMATES USING DAPHNIA MAGNA,
Monsanto Co., St. Louis, MO.
W. J. Adams, and B. B. Heidolph.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 87-103, 7 tab, 18 ref.

Descriptors: *Daphnia, *Toxicity, *Life-cycle tests, *Toxicology, *Aquatic toxicology, *Bioassay, Population dynamics, Costs, Lethal limits, Economic aspects, Biological studies.

The use of a partial life cycle test together with an application factor (AF) is a reliable way to estimate the traditional Daphnia magna 21-day GM-MATC. Application factors were determined for twelve different endpoints from 20 D. magna 21-day chronic tests by dividing the respective endpoints by the 21-day GM-MATC for each chemical. The data indicate that the 48-h no-effect concentration, the 7-, 14-, and 21-day EC sub 50 values, and the 7- and 14-day geometric mean no-effect/effect concentrations can be used with small AFs to reliably estimate the 21-day GM-MATC. The respective AFs are 2.9, 6.0, 2.0, 4.2, and 2.7. The cost associated with obtaining an estimate of the 21-day GM-MATC from a 2-, 7-, 14-, or 21-day study is $800, $5000, $10 000, and $15 000, respectively. The 48-h no-effect concentration provides the shortest and most effective test and does so without sacrificing accuracy. For purposes of ranking chemicals and obtaining preliminary estimates of environmental safety margins, the use of a 48-h no-effect concentration from an acute toxicity test and an AF (33) is recommended as a cost effective way to estimate the chronic geometric mean maximum acceptable toxicant concentration (GM-MATC) for D. magna. The results of this study indicate that there are only minor differences between 14- and 21-day GM-MATCs. Therefore, it is recommended that standard protocols for testing D. magna be changed to require only a 14-day period of exposure instead of 21 days. The results of this study also provide evidence that a chronic test as short as 7 days could be conducted without significant loss of accuracy. (See also W89-01930) (Author's abstract)
W89-01936

NEW AQUATIC BIOASSAY TECHNIQUE USING WYEOMYIA SMITHII, THE PITCHER-PLANT MOSQUITO,
Air Force Occupational and Environmental Health Lab., Brooks AFB, TX.
D. Strickman.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 104-116, 5 fig, 2 tab, 21 ref.

Descriptors: *Bioassay, *Mosquitoes, *Larvae, *Aquatic toxicology, *Toxicology, Detergents,

Heptachlor epoxide, Malathion, Insecticides, Toxicity, Lethal limits, Copper, Zinc, Manganese.

A new bioassay using larvae of the pitcher-plant mosquito, Wyeomyia smithii, was used to assess water for the presence of toxic contaminants. Procedurally, the bioassay has the advantages of simplicity, minimum equipment requirements, and low maintenance. It is well suited for bioassays of water from remote sites because of the minimal amount of water (30 ml) necessary for each replicate. The bioassay was capable of detecting 30 ppm of 1 Stroke Ves-Phene (a disinfectant detergent concentrate containing phenates), 5 ppb of heptachlor epoxide, and 100 ppb of malathion. In addition to reducing survival, toxicants caused delayed development and produced signs of intoxication unique to each substance. In another instance, the bioassay was used in the investigation of a fish kill. Persistence of toxicity, delayed development, and non-nervous signs of intoxication indicated which samples were contaminated and suggested that heavy metals were involved. Subsequent analysis revealed toxic levels of copper and elevated levels of zinc and manganese. (See also W89-01930) (Author's abstract)
W89-01937

EFFECTS OF SMALL FISH PREDATION ON MICROCOSM COMMUNITY BIOASSAY,
Washington Univ., Seattle. Coll. of Ocean and Fishery Sciences.
M. C. Harrass, and F. B. Taub.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 117-133, 5 fig, 3 tab, 32 ref. FDA Contract Nos. 223-76-8348 and 223-80-2352.

Descriptors: *Predation, *Fish behavior, *Bioassay, *Ecological effects, *Toxicology, *Aquatic toxicology, Ecosystems, Fish, Simulation analysis, Filtration, Streptomycin, Algae.

Fish predation has been recognized to influence community composition and structure, but has not been represented in experimental community tests of chemical effects. To investigate the feasibility of including vertebrate predation in 65-L microcosms, four species of small fish (Gasterosteus aculeatus, Cottus asper, Poecilia reticulata, and Pimephales promelas) were tested. These studies suggest that predation can be included in moderately sized microcosms only if exposure is restricted either by limiting the time of fish presence or by allowing the fish access to a limited portion of the microcosm. Predation was simulated by filtration of fixed proportions of the microcosms; no major changes were observed, which suggests that microcosm communities can tolerate removal of at least 25% of selected zooplankton populations per week. Fish predation did not alter the ability to detect direct effects of a selective algicide (streptomycin) on the algae, but did reduce the ability to detect indirect effects on cladoceran and ostracod populations. (See also W89-01930) (Author's abstract)
W89-01938

FACTORS AFFECTING GROWTH AND SURVIVAL OF THE ASIATIC CLAM, CORBICULA SP., UNDER CONTROLLED LABORATORY CONDITIONS,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5C.
W89-01939

METHOD FOR EARLY LIFE-STAGE TOXICITY TESTS USING THREE ATHERINID FISHES AND RESULTS WITH CHLORPYRIFOS,
Environmental Research Lab., Gulf Breeze, FL.
For primary bibliographic entry see Field 5C.
W89-01940

COMPARISON OF SYSTEM DESIGN AND REPRODUCIBILITY TO ESTIMATE BIOCONCENTRATION OF DI-N-HEXYLPHTHALATE BY DAPHNIA MAGNA,
New York Cooperative Fishery Research Unit, Ithaca, NY.
S. P. Gloss, and G. R. Biddinger.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 202-213, 4 fig, 1 tab, 26 ref. EPA Contract No. AD-14-8-0-183-0.

Descriptors: *Bioaccumulation, *Daphnia, *Di-n-hexylphthalate, *Bioassay, *Path of pollutants, *Bioaccumulation, *Toxicology, *Aquatic toxicology, Algae, Food chains, Sunfish, Predation.

Duplicated flow-through exposure systems consisting of two diluters, operated simultaneously, were used to compare the bioconcentration of 14-C-di-n-hexylphthalate (14-C-DHP) by Daphnia magna under single-species (modular) or multispecies (mixed) model formats proposed for use as microcosms to estimate bioconcentration. Triplicate exposures of Daphnia in each diluter system were made under conditions which provided the followingpossible sources of DHP: (1) water only fed (Daphnia in mixed model fed unlabeled algae), (2) water only unfed, (3) water plus food (labeled algae), and (4) food only. Water levels of 14-C-DHP were maintained at approximately 0.22 micrograms/L. Algae (Selenastrum capricornutum), previously exposed in water with 0.08 micrograms/L 14-C-DHP and used to feed Daphnia, contained approximately 0.11 micrograms 14-C-DHP/gm. Results at 24 h showed significantly ($P < 0.05$) higher accumulation of 14-C-DHP in Daphnia exposed to the combination of contaminated food and water than any other treatment. Accumulation from exposures only to food was not different from controls. No differences were detected between the same treatments in the duplicate exposure systems. Coefficients of variation within a treatment combining replicates from both diluters ($N >$ or $= 4$) averaged 18% and ranged from 8 to 32%. Exposures to 14-C-DHP in water only (Daphnia fed) were conducted in a mixed model system wherein Daphnia were subjected to controlled predation by bluegill sunfish (Lepomis macrochirus). Results from the mixed model systems suggested that steady-state accumulation took longer than seven days to achieve. The measured bioconcentration factor (BCF) of 2350 for 14-C-DHP in D. magna was similar to values reported for other phthalate esters in microcrustaceans. Measured MCFs for the water only (48 h), food plus water (48 h), and the mixed model system (14 days) were 1066, 1486, and 3254, respectively. Calculated BCFs, using a first-order steady-state equilibrium model were 998, 1414, and 4655, respectively, for the same three treatments. All BCFs reported are for total 14-C activity on a wet-weight basis. (See also W89-01930) (Author's abstract)
W89-01943

SEDIMENT MICROBIAL ACTIVITY TESTS FOR THE DETECTION OF TOXICANT IMPACTS,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
G. A. Burton, and G. R. Lanza.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 214-228, 2 fig, 4 tab, 42 ref.

Descriptors: *Sediment contamination, *Aquatic toxicology, *Ecological effects, *Pollutant identification, *Bioassay, *Fate of pollutants, *Toxicology, *Microbiological studies, Water quality, Arsenic, Bacteria, Enzymes.

Sediments are a major factor influencing the fate and concentration of some toxicants. The use of sediment microbial activity in water quality assessment could enhance our ability to understand the impact of many toxicants. Sediments from six diverse lake sites were spiked with arsenic species, and effects on microbial activity were assessed with a test battery measuring dehydrogenase (TTC), acridine orange direct counts (AODC), formazan crystal production (INT), phosphatase, proteolysis, total direct counts (DC), direct viable counts (DVC), and total plate counts (TPC). Individual tests were modified for use in sediments. Oxygen, sediment age and volume, incubation time, diluent type, nutrient amendment, and agitation were studied as major variables. Phosphatase and TTC activity were higher in microaerobic sediment microcosms. DVC accurately detected microbial activity in water but not in sediments. INT assays revealed that sediments contain higher percentages of dormant bacteria than overlying waters. Arsenic generally failed to suppress enzyme activity in nutrient-stimulated sediments. TTC, phosphatase, and INT activity showed variable responses to arsenic additions, depending on test conditions. Proteolysis was suppressed by arsenite under aerobic conditions after one month. Sediment bacterial isolates were not sensitive to arsenate, but they were very susceptible to arsenite. Important test modifications enabling accurate assessment with these assays include both sediment and nutrient concentrations, diluent type, and incubation condition. The activity test sequence described here demonstrates the diversity of microbial community response to model toxicants. The use of several microbial activity tests best defines the degree of stimulation or inhibition in sediment toxicology. The diverse and complex nature of typical sediments requires careful pretesting before accurate activity assays can be run. (See also W89-01930) (Author's abstract)
W89-01944

APPROACH TO SEWAGE SLUDGE BIOACCUMULATION POTENTIAL TESTS,
Ecological Analysts, Inc., Sparks, MD.
For primary bibliographic entry see Field 5C.
W89-01946

METHOD OF ASSESSING THE TOXICITY OF CONTAMINATED FRESHWATER SEDIMENTS,
EG and G Bionomics, Wareham, MA. Aquatic Toxicology Lab.
G. A. LeBlanc, and D. C. Surprenant.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 269-283, 1 fig, 8 tab, 28 ref.

Descriptors: *Bioassay, *Toxicity, *Sediment contamination, *Water pollution effects, *Aquatic toxicology, *Pollutant identification, *Toxicology, Fathead minnows, Midges, Daphnia, Lethal limits.

A test method was developed to assess the toxicity of freshwater dredged sediments. Toxicity of contaminated sediments was detected by monitoring survival and growth of fathead minnows (Pimephales promelas), emergence and egg hatchability of midges (Paratanytarsus parthenogenica), survival and reproduction of daphnids (Daphnia magna), and changes in microorganism populations. All organisms were exposed for 21 days in an apparatus that recirculated water through a compartment containing the sediments. In addition, a ranking scheme was proposed with which bulk sediment analyses for chemical contaminants could be condensed into a single value termed the hazard index. The hazard index was calculated for each sediment sample and was indicative of the degree of chemical contamination of the sediment. Sediments were classified as highly polluted, moderately polluted, or relatively nonpolluted, based on their hazard index. Eighty-six dredged sediment samples were tested. All biological parameters measured, except midge egg hatchability, were instrumental in detecting toxicity associated with the sediments. Effects were observed with 74% of the highly polluted sediments, 38% of the moderately polluted sediments, and 36% of the relatively nonpolluted sedi-

ments. The sublethal parameters measured were important indicators of toxicity. (See also W89-01930) (Author's abstract)
W89-01947

PHOXOCEPHALID AMPHIPOD BIOASSAY FOR MARINE SEDIMENT TOXICITY,
Environmental Research Lab.-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center.
R. C. Swartz, W. A. DeBen, J. K. P. Jones, J. O. Lamberson, and F. A. Cole.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 284-307, 1 fig, 6 tab, 45 ref, append.

Descriptors: *Marine sediments, *Bioassay, *Amphipods, *Toxicity, *Water pollution effects, *Pollutant identification, *Toxicology, *Aquatic toxicology, Mortality, Lethal limits, Sediment contamination, Salinity.

The relative toxicity of marine sediment can be accurately determined through acute, static bioassays with the phoxocephalid amphipod Rhepoxynius abronius. Mortality and sublethal effects on emergence from sediment and reburial behavior are determined after ten day exposure in 1-L beakers containing 175 ml of test sediment, 775 ml of seawater (25 ppt, 15 C), and 20 amphipods. Response of amphipods to test sediment is compared with response in control sediment collected from the species' natural habitat. Mean survival under control conditions is 95%. With five replicates the bioassay is 75% certain of detecting statistical significance when mean survival is reduced by 15%. The method can be applied to a great variety of sediment types because of the tolerance of R. abronius to a broad range of sediment grain sizes and levels of organic enrichment. The bioassay can be applied to determine: (1) the toxicity of sediment subject to regulatory decision (e.g., dredging or disposal), (2) the spatial distribution of sediment toxicity along pollution gradients or near point sources, and (3) the LC sub 50 of contaminants added to unpolluted sediment. The species' sensitivity to low salinity limits the method to sediment from the coastal zone and lower portion of estuaries. (See also W89-01930) (Author's abstract)
W89-01948

STATISTICAL TEST PROCEDURE FOR EFFLUENT TOXICITY SCREENING,
SCI Data Systems, Inc., Annapolis, MD.
P. D. Mowery, J. A. Fava, and L. W. Claflin.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 308-318, 4 fig, 3 tab, 4 ref.

Descriptors: *Statistical analysis, *Toxicity, *Water quality control, *Wastewater disposal, *Aquatic toxicology, *Toxicology, *Bioassay, Statistical studies, Water pollution effects.

The screening of effluent toxicity by comparing survival proportions between effluent-treated and control groups of test organisms is discussed. If the effluent is nontoxic, survival proportions should be similar for both groups. However, because of differences in sensitivity of individual test organisms, these proportions will not necessarily be identical. Furthermore, the number of organisms surviving from test to test will vary, even though identical effluent samples and identical laboratory procedures are used for all tests. Described here is a statistical test for determining when effluent and control group survival proportions are significantly different, thereby indicating a potentially toxic effluent. The paper emphasizes the statistical power of the test for detecting effluents of various toxicities. It also evaluates the probability that an effluent will be incorrectly judged to be toxic. The four key statistical parameters that determine the usefulness of the test are described: statistical power (i.e., the probability of correctly recognizing a toxic effluent); Type 1 error rate (i.e., the probability of incorrectly judging an effluent to be toxic); effect size (i.e., the true but unknown difference between effluent and control long-run survival proportions); and sample size. (Graphs showing the relationships between these four parameters are included). As the number of organisms used in the test is increased, the power of the test also increases. An experimental design procedure using this test and the statistical power-sample size tradeoff is also described. (See also W89-01930) (Author's abstract)
W89-01949

ISOLATION AND CHEMICAL CHARACTERIZATION OF PETROLEUM REFINERY WASTEWATER FRACTIONS ACUTELY LETHAL TO DAPHNIA MAGNA,
Enwright Labs., Greenville, SC.
C. H. Reece, and S. L. Burks.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 319-332, 1 fig, 8 tab, 22 ref.

Descriptors: *Pollutant identification, *Daphnia, *Oil refineries, *Oil wastes, *Toxicology, *Chemical analysis, *Bioassay, *Aquatic toxicology, Toxicity, Activated carbon, Filtration, Organic compounds, Gas chromatography, Mass spectrometry, Aromatic compounds, Hydrocarbons.

The object of this study was to isolate and chemically characterize the most acutely toxic fraction of a petroleum refinery wastewater. Daphnia magna static bioassays were used to characterize the relative toxicity of each fraction. Steam stripping the wastewater concentrated the toxicity in a volatile fraction. Activated carbon filtration removed the toxicity but cation exchange did not, indicating that organics are the toxic agents. Methylene chloride extraction of the volatile portion at pH > 11 followed by silica gel column chromatography resulted in an aromatic residue which was acutely toxic when dissolved in culture water. The combination of selected fractionation followed by Daphnia bioassays of each fraction determined the characteristics of the most toxic fraction to be steam volatile, base-neutral, and aromatic. Eleven compounds (polycyclic aromatic hydrocarbons) with a total concentration of 1100 micrograms/L and accounting for 28% of the total peak area of the chromatogram were identified in the aromatic fraction by a gas chromatograph/mass spectrometer (GC/MS). The mass spectra of the unidentified compounds indicated that they were probably nonhalogenated heterocyclics with molecular weights of 180 to 300, containing nitrogen, oxygen, or sulfur atoms. Some of the unidentified compounds appeared to be hydroxylated forms of the parent compounds which were identified. (See also W89-01930) (Author's abstract)
W89-01950

BIOLOGICAL IMPLICATIONS OF THE MANAGEMENT OF WASTE MATERIALS: THE IMPORTANCE OF INTEGRATING MEASURES OF EXPOSURE, UPTAKE, AND EFFECTS,
National Ocean Service, Seattle, WA. Ocean Assessments Div.
For primary bibliographic entry see Field 7A.
W89-01951

ANALYSIS OF PESTICIDES IN WATER. VOLUME I: SIGNIFICANCE, PRINCIPLES, TECHNIQUES, AND CHEMISTRY OF PESTICIDES.
CRC Press, Inc., Boca Raton, FL. 1982. 202 p. Edited by Alfred S. Y. Chau, B. K. Afghan, and James W. Robinson.

Descriptors: *Pesticides, *Pollutant identification, *Chemical analysis, *Water analysis, Insecticides, Water quality, Organic compounds.

Since analytical data are used for various stages in the activities of international and national environmental protection and pollution control, the analytical data thus have far-reaching political, scientific, and financial implications and impact. When there is no information on the quality of data, the decisions based on them, at best, are questionable. At worst, if the data are poor, irrational decisions will result. Therefore, an effective quality assurance program is needed to ensure the reliability of data. Suitable analytical methodology is the first consideration in an effective quality assurance program for the generation of reliable data. Unlike the situation of inorganic pollutants, the nature of organic pollutants is extremely complex and diversified. The number and types of organic pollutants including pesticides are also constantly increasing and changing. In three volumes on pesticides, a detailed survey of the analytical methodology and the essential background information emphasizing the practical aspects derived from evaluation of literature data and laboratory experience is presented. The pros and cons of the different methods, viewpoints, and approaches are also discussed. This first volume provides background information on pesticides, through discussions of: (1) environmental impact and significance of pesticides; (2) basic principles and practices in the analysis of pesticides; (3) positive identification of pesticide residues by chemical derivatization techniques; and (4) the chemistry of cyclodiene insecticides. (See W89-01969 thru W89-01972; W89-01973; W89-01977) (Lantz-PTT)
W89-01968

BASIC PRINCIPLES AND PRACTICES ON THE ANALYSIS OF PESTICIDES,
National Water Research Inst., Burlington (Ontario).
A. S. Y. Chau, and H. B. Lee.
IN: Analysis of Pesticides in Water. Volume I: Significance, Principles, Techniques, and Chemistry of Pesticides. CRC Press, Inc., Boca Raton, FL. 1982. p 25-81, 7 tab, 93 ref.

Descriptors: *Pollutant identification, *Pesticides, *Chemical analysis, Insecticides, Organic compounds, Chemical analysis, Spectrometry, Colorimetry, Chromatography, Phosphorus, Organochlorine, Organophosphorus, Phenoxyalkanoic acid, Carbamates, Urea, Triazine, Atrazine, Carbaryl, Quality control, Carbofuran.

According to their chemical structures, pesticides are classified as follows: (1) o.c. - organochlorinated insecticide; (2) o.p. - organophosphorus insecticide; (3) herbicide acid - an organic compound which has a substituted phenoxyalkanoic acid structure or its ester form such as 2,4-D or 2,4,5-T; (4) carbamate - an ester of substituted carbamic acid which usually has a general formula of R1R2NCOOR3 (in some cases O is replaced by S) such as carbofuran, carbaryl, or benomyl; (5) urea herbicide - a compound with substituted urea structure R1R2NCONHR3, such as dinuron or linuron; (6) s-triazine - a herbicide with a substituted 1,3,5-triazine structure, such as atrazine, simazine, or prometryne; and (7) others - such as uracils, chlorinated phenols, organo-mercury and -tin compounds, as well as inorganic arsenical insecticides and many more. Analysis of pesticides can be grossly divided into two types: (1) pesticides in formulations; and (2) the residue analysis of pesticides. Analysis of pesticides in formulation is a macro analysis to give percentage of active ingredients present in the formulation by means of spectrophotometric, colorimetric, and chromatographic techniques. These methods are usually not applicable to residue analysis because of the lack of sensitivity and specificity. Pesticide residue analysis is extremely complex and tedious. It involves not only the analysis of the parent compounds, but also their metabolites, degradation products, or a combination of some of the above or all. Because of the complexity of residue analysis, two major types of analytical uncertainties may result: (1) true identify of the contaminant; and (2) real quantity of the contaminant analyzed. In order to assure the quality of analytical data, intra- and inter-laboratory quality control programs are required. Some

fundamental aspects of quality control studies are discussed. (See also W89-01968) (Lantz-PTT)
W89-01970

POSITIVE IDENTIFICATION OF PESTICIDE RESIDUES BY CHEMICAL DERIVATIZATION-GAS CHROMATOGRAPHIC TECHNIQUE,
National Water Research Inst., Burlington (Ontario).
A. S. Y. Chau.
IN: Analysis of Pesticides in Water. Volume I: Significance, Principles, Techniques, and Chemistry of Pesticides. CRC Press, Inc., Boca Raton, FL. 1982. p 83-172, 26 tab, 330 ref.

Descriptors: *Chemical analysis, *Pollutant identification, *Pesticides, *Gas chromatography, Monitoring, Mass spectrometry, Physical properties, Chemical properties, Chromatography, Costs, Economic aspects, Organic compounds.

The usefulness of the chemical derivatization technique is not just confined to the confirmation of residue identity; in fact, this technique was first used for GC analysis of less volatile or labile compounds that called for derivatization to more volatile or more stable derivatives for successful GC analysis, particularly in the presence of sample coextractives. In conjunction with the increasing use of high pressure liquid chromatography (HPLC) derivatization becomes a key step in applying this technique either before or after HPLC column separation to compensate for the limitation in the choice of HPLC detectors as compared to those available for GLC. There are several approaches analysts can select to routinely confirm identify of a compound in a sample. If money is available, there is a tendency among analysts to persuade management to buy sophisticated and expensive equipment to do a job whereas simpler and cheaper procedures or equipments can perform equally well. In this regard, many analysts favor the gas chromatography/mass spectroscopy (GC/MS) computer system rather than simpler and much cheaper procedures such as chemical derivatization techniques, p-values, and so on for confirming identify of pesticides in a routine laboratory even though the need of such a system may be practically and operationally questionable for this application. In several types of activities such as research monitoring, it is the effective tool to do the job. However, to use it only for confirmation of identify in a routine operation is overkill. Many laboratories are using chemical and/or physical procedures for confirmation of pesticides and other trace organic compounds in their routine operation, partly because of the capital and maintenance costs of a GC/MS computer system and partly because it is used more efficiently and effectively for those areas, such as research, where such a system is really needed. (See also W89-01968) (Lantz-PTT)
W89-01971

CHEMISTRY OF THE CYCLODIENE INSECTICIDES,
Carleton Univ., Ottawa (Ontario). Dept. of Chemistry.
J. W. ApSimon, and K. Yamasaki.
IN: Analysis of Pesticides in Water. Volume I: Significance, Principles, Techniques, and Chemistry of Pesticides. CRC Press, Inc., Boca Raton, FL. 1982. p 173-196, 39 ref, 57 ref, append.

Descriptors: *Chemical analysis, *Cyclodiene, *Insecticides, Chemical reactions, Molecular structure, Chemical properties, Wagner-Meerwein rearrangements.

The chemistry of the cyclodiene insecticides has been reviewed especially with respect to their behavior in acidic or basic medium. Examples indicate that transannular reactions and Wagner-Meerwein rearrangements are evidence that these insecticides are provided with the intrinsic molecular compactness leading to interesting and important chemical observations in the area of strained molecules. Chemical reactions of heptachlor, chlordane, aldrin, isodrin, dieldrin, endrin, and compounds similar to these are illustrated. (See also W89-01968) (Lantz-PTT)
W89-01972

ANALYSIS OF PESTICIDES IN WATER. VOLUME II: CHLORINE- AND PHOSPHORUS-CONTAINING PESTICIDES.
CRC Press, Inc., Boca Raton, FL. 1982. 238p. Edited by A. S. Y. Chau, B. K. Afghan, and James W. Robinson.

Descriptors: *Pesticides, *Pollutant identification, *Chemical analysis, *Water analysis, Organophosphorus pesticides, Halogenated pesticides, Water quality, Organic compounds, Chorine compounds, Phosphorus compounds, Phenoxyalkyl acid.

Since analytical data are used for various stages in the activities of international and national environmental protection and pollution control, the analytical data have far-reaching political, scientific, and financial implications and impact. When there is no information on the quality of data, the decisions based on them, at best, are questionable. At worst, if the data are poor, irrational decisions will result. Therefore, an effective quality assurance program is needed to ensure the reliability of data. Suitable analytical methodology is the first consideration in an effective quality assurance program for the generation of reliable data. Unlike the situation of inorganic pollutants, the nature of organic pollutants is extremely complex and diversified. The number and types of organic pollutants including pesticides are also constantly increasing and changing. In three volumes on pesticides, a detailed survey of the analytical methodology and the essential background information emphasizing the practical aspects derived from evaluation of literature data and laboratory experience is presented. The pros and cons of the different methods, viewpoints, and approaches are also discussed. The second volume discusses: (1) organochlorine pesticides; (2) organophosphorus pesticides; and (3) phenoxyalkyl acid herbicides (CPHs). (See W89-01974 thru W89-01976; W89-01968; W89-01977) (Lantz-PTT)
W89-01973

ORGANOCHLORINE PESTICIDES,
National Water Research Inst., Burlington (Ontario). Analytical Methods Div.
H. B. Lee, A. S. Y. Chau, and F. Kawahara.
IN: Analysis of Pesticides in Water. Volume II: Chlorine- and Phosphorus-Containing Pesticides. CRC Press, Inc., Boca Raton, FL. 1982. p 1-60, 18 tab, 189 ref.

Descriptors: *Halogenated pesticides, *Pesticides, *Chemical analysis, Chemical properties, Physical properties, Cyclodiene, DDT, Molecular structure.

Most pesticides are synthetic chemicals, and could be classified by chemical type. However, pesticides can be more usefully classified by considering their intended targets. Organochlorine pesticides are insecticides in target. Organochlorines consist of two different major groups based on their molecular structures, namely, the cyclodiene or diene group and the DDT group. Cyclodiene insecticides are cyclic compounds possessing the characteristic 'endomethylene bridged' structure. With one exception, all the cyclodiene insecticides are the Diels-Alder reaction products of hexachlorocyclopentadiene and a suitable unsaturated compound. Chlordane, heptachlor, isodrin, and aldrin are products of Diels-Alder reactions; dieldrin, heptachlor epoxide, and endrin are prepared by the epoxidation of aldrin, heptachlor, and isodrin, respectively. Toxaphene, the exception, is produced by the chlorination of camphor. All these compounds contain six or more chlorine atoms in the molecule. DDT and its analogs that contain two aromatic rings represent the other major group in o.c. pesticides. Methoxychlor, DDD, perthane, and kelthane are some examples of this group. In pesticide residue analysis for environmental studies, cyclodiene and DDT-type insecticides together with lindane (gamma-benzene hydrochloride) are often encountered. The analysis of organochlorines is discussed as is their structures, synthesis, and physical and chemical properties. (See also W89-01973) (Lantz-PTT)
W89-01974

ORGANOPHOSPHORUS PESTICIDES,
National Water Research Inst., Burlington (Ontario).
A. S. Y. Chau, B. D. Ripley, and F. Kawahara.
IN: Analysis of Pesticides in Water. Volume II: Chlorine- and Phosphorus-Containing Pesticides. CRC Press, Inc., Boca Raton, FL. 1982. p 61-154, 12 fig, 20 tab, 311 ref, append.

Descriptors: *Organophosphorus pesticides, *Pesticides, *Chemical analysis, *Path of pollutants, *Fate of pollutants, Water pollution effects, Water analysis, Hydrolysis, Chemical properties, Chemical reaction, Phenols, Tissue analysis, Bioaccumulation, Water analysis.

Organophosphorus (o.p.) insecticides have been used for agricultural purposes for at least 30 years. Since many of the organochlorine (o.c.) pesticides have been withdrawn from registered use because of the mounting evidence on their toxicity, persistence, and bioaccumulation in the environment, the o.p. insecticides have become one of the important groups of insecticides replacing the cheaper o.c.'s in many agricultural applications in the western world. Although o.p. pesticides, can be as toxic or even more toxic to humans and to aquatic life, their propensity for relatively short persistence favors their usage. Studies on the hydrolysis rate of o.p. pesticides indicate that these compounds are more labile than their o.c. counterparts; however, their decay in river water may be at rates sufficiently slow to constitute a potential pollution hazard. In the aquatic environment, one major type of breakdown product of the o.p. pesticides containing a phenol or thiophenol group is the phenol moiety arising from hydrolysis. Phenolic compounds are known to affect the odor and quality of drinking water and they may be chlorinated in some types of water treatment plants to produce undesirable chlorinated compounds. Methods specific for water analysis are discussed and a suitable multi-residue method is detailed. The methodology of the chosen procedure is discussed in detail. As yet, there is no multi-residue method designed specifically for the analysis of o.p. pesticides in sediment and fish samples; however, some discussion on the analysis of these substrates is included based on published methods for soil, plants, and animal tissue. (See also W89-01973) (Lantz-PTT)
W89-01975

PHENOXYALKYL ACID HERBICIDES (CPHS),
Ontario Ministry of Agriculture and Food, Guelph. Pesticide Residue Lab.
G. J. Sirons, A. S. Y. Chau, and A. E. Smith.
IN: Analysis of Pesticides in Water. Volume II: Chlorine- and Phosphorus-Containing Pesticides. CRC Press, Inc., Boca Raton, FL. 1982. p 155-227, 5 fig, 22 tab, 175 ref.

Descriptors: *Pollutant identification, *Phenoxyalkyl acids, *Herbicides, *Water analysis, Chemical analysis, Extraction, Chemical reactions, Esters, Adsorption, Solubility.

The analytical procedures for the extraction and quantitation of chlorophenoxy alkanoic acids have been known for some time. Procedures involve extracting solvents which vary from acetone, acetonitrile, 2-propanol, methanol, ethanol, benzene, and diethyl ether to sodium and potassium hydroxide and bicarbonate solutions. After extraction, which in most cases is associated with acidic or alkaline hydrolysis, the phenoxyalkanoic acids are partitioned in order to purify and separate them from substrates. To render the acids suitable for FLC quantitation, they are esterified, and a column cleanup introduced. The recoveries including esterification losses vary from 75 to 95% or better. It has been known for some time that, in general, recovery data are not reliable, in particular with short-time fortification and, therefore, considerable care should be exercised when analytical methods are evaluated. The conjugation (about 10%), the solubilities in water (40 to 600 ppmw), the glass adsorption (occasionally complete), contamination, and derivatization efficiency (45 to 99%) are factors responsible for fluctuation in analytical results. (See also W89-01973) (Lantz-PTT)
W89-01976

ANALYSIS OF PESTICIDES IN WATER. VOLUME III: NITROGEN-CONTAINING PESTICIDES.
CRC Press, Inc., Boca Raton, FL. 1982. 248p.
Edited by Alfred S. Y. Chau, B. K. Afghan, and James W. Robinson.

Descriptors: *Pesticides, *Pollutant identification, *Chemical analysis, *Water analysis, Water quality, Organic compounds, Herbicides, Triazine, Urea, Carbamates.

Since analytical data are used for various stages in the activities of international and national environmental protection and pollution control, the analytical data have far-reaching political, scientific, and financial implications and impact. When there is no information on the quality of data, the decisions based on them, at best, are questionable. At worst, if the data are poor, irrational decisions will result. Therefore, an effective quality assurance program is needed to ensure the reliability of data. Suitable analytical methodology is the first consideration in an effective quality assurance program for the generation of reliable data. Unlike the situation of inorganic pollutants, the nature of organic pollutants is extremely complex and diversified. The number and types of organic pollutants including pesticides are also constantly increasing and changing. In three volumes on pesticides, a detailed survey of the analytical methodology and the essential background information emphasizing the practical aspects derived from evaluation of literature data and laboratory experience is presented. The pros and cons of the different methods, viewpoints, and approaches are also discussed. The third volume discusses: (1) carbamates; (2) the substituted urea herbicides; and (3) triazine herbicides). (See W89-01978 thru W89-01980; W89-01968; W89-01973) (Lantz-PTT)
W89-01977

CARBAMATE PESTICIDES,
Ontario Ministry of Agriculture and Food, Guelph. Pesticide Residue Lab.
B. D. Ripley, and A. S. Y. Chau.
IN: Analysis of Pesticides in Water. Volume III: Nitrogen-Containing Pesticides. CRC Press, Inc., Boca Raton, FL. 1982. p 1-182, 69 fig, 28 tab, 804 ref, append.

Descriptors: *Pollutant identification, *Pesticides, *Path of pollutants, *Fate of pollutants, *Biodegradation, *Carbamates, *Chemical analysis, Organic compounds, Insecticides, Literature review, Methylcarbamate.

The 'carbamate' class of pesticides is quickly gaining importance in the field of pest control. Generally the carbamate insecticides demonstrate a high insect toxicity, but have a low toxicity towards warm blooded nontarget species, are more biodegradable and less persistent than the organochlorine (o.c.) pesticides, and have relatively less toxic decomposition products. The biological activity of synthetic carbamate pesticides is due to the type of substitution to the basic carbamate moiety that results in these compounds being effective insecticides, herbicides, fungicides, nematicides, miticides, and molluscicides. The insecticidal carbamates are derivatives of carbamic acid and are therefore structurally related. Most of the herbicidal and fungicidal carbamates differ structurally from the carbamate insecticides, being primarily thiocarbamates and dithiocarbamates, respectively. The intensive use of carbamates and other pesticides in concentrated agricultural areas usually near waterways suggests that continued studies should be done to develop baseline levels in environmental samples. Residues of carbamate pesticides in the environment often appear to be transient, but after point source contamination (due to spills, misapplication, runoff, etc.) the level of residues can often contribute significantly to the aquatic system and cause direct short-term toxic effects. Residue methods need to be expanded to allow the monitoring of many carbamates that are routinely used but not often analyzed. Some aspects of the general chemistry, environmental persistence, and metabolism of carbamate pesticides are covered, but the major emphasis is concerned with analytical residue methodology. The discussions are devoted primarily to the carbamate insecticides, specifically the N-methylcarbamates, but the other carbamate pesticides are considered. Although a comprehensive literature review is not intended, most of the major contributions have been considered and several of the more common analytical procedures have been detailed. (See also W89-01977) (Lantz-PTT)
W89-01978

SUBSTITUTED UREA HERBICIDES,
Agriculture Canada, Regina (Saskatchewan). Research Station.
A. E. Smith, and R. Grover.
IN: Analysis of Pesticides in Water. Volume III: Nitrogen-Containing Pesticides. CRC Press, Inc., Boca Raton, FL. 1982. p 183-211, 14 tab, 59 ref.

Descriptors: *Pollutant identification, *Urea, *Herbicides, *Path of pollutants, *Water analysis, *Fate of pollutants, Physical properties, Chemical analysis, Chemical properties, Toxicity, Molecular structure, Monuron, Fenuron, Diuron, Neburon, Sediment, Aquatic plants.

The substituted urea herbicides are derivatives of urea (H2NCONH2), and the first compounds to be synthesized contained an amino moiety fully substituted with alkyl or alkoxy groups, while the second amino function contained a single mono- or di-halogenated phenyl group. Currently there are about 20 such aryl-dialkyl or aryl-alkyl-alkoxy urea derivatives and 10 structures based on heterocyclic substituents available as herbicides. Monuron, the first phenylurea herbicide to be synthesized, was described in 1951, and several other substituted ureas were quickly developed, such as fenuron, diuron, and neburon, setting the commercial use of urea derivatives as herbicides on a practical basis. The use and application of these substituted urea herbicides, with their synthesis, physical properties, chemical properties, and toxicological properties are reported. Environmental aspects, review of analytical procedures, analytical methodology, and detailed analytical procedures are discussed. (See also W89-01977) (Lantz-PTT)
W89-01979

TRIAZINE HERBICIDES,
Agriculture Canada, Regina (Saskatchewan). Research Station.
A. E. Smith, D. C. G. Muir, and R. Grover.
IN: Analysis of Pesticides in Water. Volume III: Nitrogen-Containing Pesticides. CRC Press, Inc., Boca Raton, FL. 1982. p 213-239, 11 tab, 88 ref.

Descriptors: *Pollutant identification, *Triazine pesticides, *Herbicides, *Path of pollutants, *Water analysis, Chemical analysis, Sample collection, Sample preparation, Molecular structure, Atrazine, Simazine, Terbutryn.

With few exceptions, the triazine herbicides are based on a s-triazine structure containing two substituted amino groups, while the third ring carbon atom possesses a chloro-, methoxy-, or azido-grouping. There are about 25 triazine derivatives that have been developed as commercial herbicides or are in experimental use. The most commonly used triazine herbicides are undoubtedly atrazine and simazine, which are extensively used throughout the world. The use patterns of the most commonly encountered triazine herbicides are summarized in tables, together with their application rates. Simazine and terbutryn are the only triazine herbicides used for the selective control of algae and submerged weeds in aquatic situations such as ponds, swimming pools, recirculating water cooling towers and fountains. Formulations and application rates, synthesis, physical properties, chemical properties, and toxicological properties are reported. Environmental aspects, a review of analytical procedures, analytical methodology, sample collection, preservation, and preparation, and detailed analytical procedures are also included. (See also W89-01977) (Lantz-PTT)
W89-01980

ANOMALIES IN OIL AND GREASE ANALYSES OF PETROLEUM WASTEWATERS AND THEIR IMPLICATIONS,
Shell Oil Co., Houston, TX.
P. T. Sun, C. L. Price, J. C. Raia, and R. A. Balderas.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 151-162, 11 fig, 6 tab, 20 ref.

Descriptors: *Wastewater treatment analysis, *Water analysis, *Pollutant identification, *Oil wastes, *Grease, *Oil, Phenols, Organic compounds, Industrial wastewater, Chemical analysis, Oil refineries, Biodegradation, Gravimetry, Hydrocarbons.

The presence of certain soluble organics, such as phenolics, short chain carboxylics and naphthenic acids, in refinery wastewater streams causes significant interferences in oil and grease analyses. In certain cases, the interference results in oil and grease concentrations 200% higher than the true hydrocarbon concentration in refinery waste. The degree of interference depends on the method used in the analysis. The EPA specified Method 503A/partition-gravimetric procedure and some oil/water monitors using the extraction/IR principle will extract the greatest quantity of soluble components. Thus, without some sort of modifications, they are the least preferred methods for analysis of refinery wastewater samples. The Soxhlet/Method 503C will be affected by certain naphthenic components, but not the low molecular weight compounds. The Hydrocarbons/Method 503E only detects the immiscible oil phase and is least affected by the soluble oil and grease components. The modified oil/water monitor procedure, with pH of sample elevated to 12 prior to extraction, can give a good estimate of the 'true' oil content. The soluble oil and grease components have been shown to be easily biodegradable. Under normal conditions, they would not cause inhibition, pass-through, or sludge accumulation problems for the receiving public operated treatment works. The data base used in the Development Document for Pretreatment may not be based solely on the EPA specified Method 503A oil and grease analytical procedure. The significant interference problem caused by the soluble components was apparently not being taken into consideration in the establishment of the pretreatment standard for oil and grease. It is believed that specifying Method 503A in analyzing wastewater samples under the current pretreatment program may be inconsistent with the database and may not be justified by the original objective of the standard. (See also W89-02006) (Lantz-PTT)
W89-02023

EFFLUENT TOXICITY MONITORING METHODOLOGY EVALUATED FOR FIVE INDUSTRIAL DISCHARGERS,
Engineering-Science, Fairfax, VA.
For primary bibliographic entry see Field 5D.
W89-02030

USE OF CHRONIC BIOASSAYS FOR PULP AND PAPER MILL EFFLUENTS IN WISCONSIN,
Wisconsin Dept. of Natural Resources, Madison.
M. D. Witt, M. D. Hammers, and R. G. Masnado.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 257-264, 4 fig, 8 tab, 8 ref.

Descriptors: *Bioassays, *Pulp and paper industry, *Wisconsin, *Water pollution effects, *Water pollution prevention, Toxicity, Industrial wastewater, Fathead minnows, Daphnia.

In Wisconsin, the expiration of 36 pulp and paper mill NPDES permits in late 1986 and early 1987 presented an opportunity for the Wisconsin Department of Natural Resources, to gain experience with recently developed 7-day chronic bioassays. As part of their application for permit reissuance, these 36 permittees were requested to perform 7-day chronic bioassays on their wastewater discharges. The Department believed that the bioassay results, in addition to the extensive analytical

data on chemical parameters normally submitted by the permittee in the reissuance application, would provide a broader data base to evaluate effluent toxicity. The results of the 37 toxicity tests were received by the Department to date, but because of a lack of homogeneity of variance among the data, as indicated by significance using Bartlett's test ($P < 0.05$), Steel's Many-One Rank tested was used instead of Dunnett's procedure to statistically analyze the data for 24 of 36 Ceriodaphnia dubia data sets and 4 of 37 larval fathead minnow data sets. Chronic toxicity in excess of the State's criteria was evident in only 5 effluents. Inadequate data and concerns about the test protocols prevent the Department from conclusively identifying the toxicity of individual mill effluents. However, the data as a whole indicate the existence of acute and chronic toxicity within this industrial category. The C. dubia and larval fathead minnow 7-day sub-chronic toxicity tests can be useful for evaluating effluent toxicity. However, further development and standardization of the test protocols must be made before whole effluent toxicity limits are placed in the WPDES permits. (See also W89-02006) (Lantz-PTT)
W89-02031

CLASSIFYING INDUSTRIAL SLUDGE USING A KNOWLEDGE-BASED EXPERT SYSTEM,
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-02044

CHARACTERIZATION OF TREATMENT RESIDUES FROM HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES,
Metcalf and Eddy, Inc., Wakefield, MA.
For primary bibliographic entry see Field 5D.
W89-02045

HEAVY METALS IN WASTEWATER AND SLUDGE TREATMENT PROCESSES. VOLUME I: SOURCES, ANALYSIS, AND LEGISLATION.
CRC Press, Boca Raton, Florida, 1987. 183p.
Edited by John N. Lester.

Descriptors: *Heavy metals, *Wastewater, *Pollutant identification, *Water pollution sources, *Legislation, Cadmium, Chromium, Copper, Mercury, Nickel, Lead, Zinc, Regulations, Chemical analysis, Speciation.

In the first of two volumes on heavy metals in wastewater attention is focussed on the sources and analysis of the metals and on legislation aimed at at their control. The six chapters include: (1) a definition of the scope of the problem; (2) sources of heavy metals in wastewater; (3) pollution control legislation; (4) determination of heavy metals in wastewater matrices; (5) chemical speciation of heavy metals in sewage sludge; and (6) physical and electrochemical speciation. (See W89-02098 thru W89-02104) (Lantz-PTT)
W89-02097

DETERMINATION OF HEAVY METALS IN WASTEWATER MATRICES,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
R. M. Sterritt.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume I: Sources, Analysis, and Legislation. CRC Press, Boca Raton, Florida, 1987. p 105-124, 1 fig, 7 tab, 76 ref.

Descriptors: *Heavy metals, *Wastewater, *Chemical analysis, Atomic absorption spectrophotometry, Economic aspects, Atomization, Electrothermal atomization, Municipal wastewater.

Of the variety of analytical techniques available for the determination of heavy metals, atomic absorption spectrophotometry fulfills most of the requirements of sensitivity, specificity, accuracy, practicability, and economy and is probably the most frequently used method for environmental samples. Atomization is normally achieved either by aspiration of the liquid sample into an air-acetylene or nitrous oxide-acetylene flame which can generate temperatures of up to about 2300 and 3000 C, respectively. Electrothermal atomization, using graphite cups, rods, or tubes has, in the last 25 years, developed to the extent where it offers an attractive alternative analytical capability for atomic absorption. The extensive proliferation of analytical methodology, particularly that based on electrothermal atomization, is evidenced by the extensive current reviews of the literature. It must be stated, however, that only a small proportion of the current research in atomic absorption spectrophotometry and other methods, including neutron activation analysis, X-ray fluorescence, inductively coupled plasmas, and polarographic techniques, is directed towards the analysis of municipal wastewaters and similar matrices. In view of the nature of the matrices involved, these wastewaters should be afforded special attention. This chapter will be confined almost entirely to these matrices. Some of the elements considered may not quality as heavy metals, but are included to illustrate certain principles. (See also W89-02097) (Lantz-PTT)
W89-02101

CHEMICAL SPECIATION OF HEAVY METALS IN SEWAGE SLUDGE AND RELATED MATRICES,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-02102

PHYSICAL AND ELECTROCHEMICAL SPECIATION,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
R. M. Sterritt.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume I: Sources, Analysis, and Legislation. CRC Press, Boca Raton, Florida, 1987. p 155-173, 2 tab, 80 ref.

Descriptors: *Path of pollutants, *Sludge, *Chemical analysis, *Heavy metals, *Speciation, Chemical reactions, Wastewater, Copper, Lead, Zinc, Cadmium, Nickel, Mercury, Manganese, Chromium, Cobalt, Ion exchange, Chromatography, Polarography, Filtration.

Little attention has been paid to heavy metal speciation in samples such as sewage, sewage effluent, and sludge due to the incidence of various matrix interference effects and some uncertainty about the validity of sensitive and specific analytical techniques applied to these complex samples. In wastewater treatment processes, approaches to speciation have been relatively unconcerned with direct toxic effects per se, but rather with understanding the partition of heavy metals into various forms or fractions which will ultimately determine their dispersion and impact in the environment. The contrasts between heavy metal speciation in natural waters and wastewaters and the environmental significance of each may ultimately lead to important conceptual differences in the rationale behind speciation in simple and complex matrices. The elements which have been considered most often in speciation studies are Cd, Cu, Pb, and Zn, and, to a lesser extent, Ni, Hg, Mn, Cr, and Co. Analytical limitations may be a major reason for the exclusion of other elements from many studies. However, the elements primarily of interest in wastewater matrices will be those recognized as important pollutants and those specified in water quality criteria and sewage sludge disposal legislation. Analytical techniques (as well as theoretical analysis) for speciation determination discussed include: (1) physicochemical and electrochemical techniques, ion-specific electrodes, ion exchange, and polarography; and (2) physical separations - gel filtration chromatography and membrane filtration. (See also W89-02097) (Lantz-PTT)
W89-02103

METHODS FOR RECOVERING VIRUSES FROM THE ENVIRONMENT.
CRC Press, Inc., Boca Raton, Florida, 1987. 236p.
Edited by Gerald Berg.

Descriptors: *Viruses, *Wastewater treatment, *Pollutant identification, *Path of pollutants, Microbiological studies, Adsorption, Sludge, Aerosols, Wastewater, Quantitative analysis.

The development of methods in environmental virology became a focus of growing interest about two decades ago. In the natural environment, even in relatively clean waters, substances such as humic and fulvic acids interfere with viral recoveries and average recovery rates probably do not reach 20%. With sewage sludges and shellfish, recoveries are undoubtedly much lower. Yet even relatively low viral recovery rates have made possible the detection of viral hazards in drinking waters, recreational waters, sludges, and in shellfish and shellfish-growing waters. Improving methods, as they are developed in the years to come, will undoubtedly bring the true extent of the hazards into better perspective. Techniques for recovering viruses from sewage effluents, sludge, aerosols, soils and aquatic sediments are discussed along with mechanisms of adsorption and elution of viruses from the environment, and microbiological techniques for their identification and quantification. (See W89-02112 thru W89-02120) (Lantz-PTT)
W89-02111

RECOVERING VIRUSES FROM SEWAGE, EFFLUENTS, AND WATER,
Arizona Univ., Tucson. Dept. of Microbiology.
C. P. Gerba.
IN: Methods for Recovering Viruses from the Environment. CRC Press, Inc., Boca Raton, Florida, 1987. p 1-23, 1 fig, 4 tab, 129 ref.

Descriptors: *Virus detection, *Water analysis, Standard, Adsorption, Elution, Enteroviruses, Drinking water, Monitoring, Water quality control, Filtration, Economic aspects, Wastewater.

Major advances have been made in the last two decades in the development of methods for concentrating viruses from large volumes of water. Development of microporous adsorption-elution techniques made possible the first practical field methods for concentrating enteroviruses from drinking water, sewage, and seawater. Although this method still has many inherent limitations, continued improvements have led to increased efficiencies of enterovirus recoveries and its use with other members of the enteric virus group such as rotaviruses and hepatitis A virus (enterovirus 72). These systems make possible the routine monitoring of water for enteric viruses. The flexibility of these systems to modification and increased knowledge of virus surface interactions should lead to continued improvement in this technology. Although microporous filter systems have proved successful for concentrating viruses, this does not portend the abandonment of other technologies. Other methods may be more appropriate when smaller volumes need to be processed or where microporous filters are not readily available or are too costly. Although ultrafiltration is still a promising alternative, it suffers from lack of portability, high equipment costs, and it has not yet been evaluated with water of varying quality. (See also W89-02111) (Lantz-PTT)
W89-02112

RECOVERING VIRUSES FROM SEWAGE SLUDGES AND FROM SOLIDS IN WATER,
Health Effects Research Lab., Cincinnati, OH.
C. J. Hurst.
IN: Methods for Recovering Viruses from the Environment. CRC Press, Inc., Boca Raton, Florida, 1987. p 25-51, 1 fig, 3 tab, 93 ref.

Descriptors: *Virus detection, *Sludge, *Suspended solids, *Wastewater treatment, *Water treatment, Bioassay, Adsorption, Chemical analysis, Centrifugation, Chemical precipitation, Flocculation.

Methods used for quantifying viruses in sludges and solids in water may be classified in two major

groups. The first group consists of directly assaying samples collected in the field, samples mixed with buffer, or supernates and filtrates produced from samples mixed with buffer. The second group entails recognition of the great extent to which many types of viruses adsorb onto solids. Within this group are approaches in which collected solids are mixed with an eluting agent and a subsequently produced eluate is assayed for viruses. Some researchers have combined the two approaches. Here, whole sludge is mixed with an eluting buffer, the solid are collected and resuspended in fresh buffer, and the supernates from both the buffer-sludge mixture (representing direct assay) and the resuspended solids (representing elution) are assayed for viruses. Several types of diluents and elution buffers have been used for recovering viruses from sludges and solids. These include distilled water, saline, detergents, high pH amino acid buffers, and solutions of dissolved organic materials that may or may not contain buffering salts. Combinations of these eluates have also been evaluated. A variety of methods have been tested for concentrating sewage sludges and waterborne solids that contain viruses. Concentration is helpful when it increases the ability to detect viruses present in small numbers, and when it reduces the high cost of assaying large quantities of material. The approaches that have been evaluated for this purpose include: high speed centrifugation to pellet the virus, filter adsorption-elution, two-phase polymer treatment, chemical precipitation, hydroextraction, organic flocculation, and adsorption onto clay solids. Of these methods, those with the greatest recent interest are hydroextraction and organic flocculation. (See also W89-02111) (Lantz-PTT)
W89-02113

RECOVERING VIRUSES FROM AEROSOLS,
Texas Univ. at Austin. Dept. of Civil Engineering.
C. A. Sorber.
IN: Methods for Recovering Viruses from the Environment. CRC Press, Inc., Boca Raton, Florida, 1987. p 53-65, 2 fig, 4 tab, 26 ref.

Descriptors: *Wastewater aerosols, *Pollutant identification, *Aerosols, *Viruses, Monitoring, Polymers, Polyethylene glycol, Bioassay.

Quantification of airborne viruses from environmental sources is a tedious process. Although sampling equipment is available and methodologies have been developed to accomplish this task, they are not readily adaptable to routine monitoring efforts. Thus, determining virus concentrations of environmental aerosols must be relegated to the category of special studies or research. In fact, there is no standard approach to this problem. Each study design must be tailored to the specific site, and it must consider the physical, meteorological, and microbiological conditions of the site. Nevertheless, the methodologies presented (two-phase polymers systems, polyethylene glycol, and viral assays) have been useful in answering some of the questions about exposure to human viruses from a number of sources. (See also W89-02111) (Lantz-PTT)
W89-02114

RECOVERING VIRUSES FROM SOILS AND AQUATIC SEDIMENTS,
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
G. Bitton.
IN: Methods for Recovering Viruses from the Environment. CRC Press, Inc., Boca Raton, Florida, 1987. p 67-75, 5 fig, 30 ref.

Descriptors: *Pollutant identification, *Soil contamination, *Aquatic sediments, *Monitoring, Hydrogen ion concentration, Elution, Public health, Chemical analysis.

Considerable emphasis has been placed upon the development of methods that allow the recovery of small numbers of viruses from relatively large volumes (up to 1000 L) of tapwater. Two recent developments, have given impetus to research on methods for recovering viruses from soils and aquatic sediments. First, recent legislation (PL 92-500) has encouraged the disposal of wastewater effluents and residuals on agricultural soils. Second, it is now recognized that aquatic sediments may act as reservoirs for bacterial and viral pathogens. Detection methodology for viruses in soils and sediments is now in the early stages of development and more attention should be focused in this area. Most investigators agree that elution at pH 9 is safer than elution at pH 11 because certain viruses of public health importance (e.g., rotaviruses) are sensitive to high pH levels. More efforts need to be devoted to the evaluation of existing methods under field situations. (See also W89-02111) (Lantz-PTT)
W89-02115

METHODS FOR RECOVERING VIRUSES FROM SHELLFISH, SEAWATER, AND SEDIMENTS,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
M. D. Sobsey.
IN: Methods for Recovering Viruses from the Environment. CRC Press, Inc., Boca Raton, Florida, 1987. p 77-108, 4 fig, 106 ref.

Descriptors: *Pollutant identification, *Viruses, *Shellfish, *Seawater, *Sediments, Bioassay, Enteroviruses, Coastal waters, Microbiological studies.

Enteric virus contamination of coastal waters, sediments, and shellfish has been documented by recovery of viruses from environmental samples and by the occurrence of water- and shellfish-borne enteric virus disease outbreaks, such as hepatitis A and viral gastroenteritis. The use of methods for detecting enteric viruses is not yet routine because these methods are technically complex, lengthy, costly, and of unknown effectiveness for many viruses of interest. The efficiency of methods for detecting enteric viruses in shellfish, seawater, and sediments is likely to vary with the types, amounts, and conditions of viruses in the samples, the characteristics, quality, and size of the samples, and the characteristics of the virus recovery and assay procedures themselves. Most of the methods have not been evaluated systematically for precision and accuracy through extensive inter- and intra-laboratory studies, or for recovery of hepatitis A virus, human rotaviruses, Norwalk virus, and other difficult-to-cultivate viruses which have been implicated most often in water- and shellfish-borne disease outbreaks. Recently, many candidate methods for enteric virus detection in shellfish, seawater, and sediments were compiled and described in detail, and a few were collaboratively tested. Methods for the virological examination of shellfish, seawater, and sediments are critically reviewed. Some of the most promising candidate methods are described in detail. (See also W89-02111) (Lantz-PTT)
W89-02116

RECONCENTRATION OF VIRUSES FROM PRIMARY ELUATES,
Baylor Coll. of Medicine, Houston, TX. Dept. of Virology and Epidemiology.
V. C. Rao.
IN: Methods for Recovering Viruses from the Environment. CRC Press, Inc., Boca Raton, Florida, 1987. p 109-126, 2 fig, 12 tab, 48 ref.

Descriptors: *Pollutant identification, *Viruses, *Water treatment, *Wastewater treatment, Adsorption, Elution, Rotaviruses, Hydrogen ion concentration, Microbiological studies.

Microporous filter adsorption-elution methods for concentrating human enteroviruses from large volumes of water seem to be applicable to the concentration of enterovirus 72 (hepatitis A virus) and rotaviruses from water and wastewater. Beef extract at slightly alkaline pH is preferred to glycine buffer at high pH (11.5) for eluting viruses from filters. Viruses can be reconcentrated from primary eluates by organic flocculation and iron oxide adsorption-elution. Both are simple and inexpensive methods that produce small volumes of concentrates that are minimally toxic to cell cultures. Improvements are needed to increase the efficiency and applicability of these methods for different environmental samples. The development of a third step concentration method for further reducing sample size is needed for detecting hard-to-cultivate viruses by immunological methods. (See also W89-02111) (Lantz-PTT)
W89-02117

METHODS FOR RAPID DETECTION AND RAPID IDENTIFICATION OF VIRUSES,
Massachusetts Univ. Medical School, Worcester. Div. of Infectious Diseases.
J. E. Herrmann.
IN: Methods for Recovering Viruses from the Environment. CRC Press, Inc., Boca Raton, Florida, 1987. p 179-194, 4 tab, 92 ref.

Descriptors: *Viruses, *Pollutant identification, Enzyme-immunoassay, Microbiological studies, Wastewater, Water quality control, Enteroviruses, Rotaviruses.

Although many of the current enzyme immunoassay (EIA) tests for viral antigens have not realized their potential, there are reasons to believe this situation will improve. For detection of antigen, which offers a rapid and direct means of diagnosing microbial infections, the major problem has been lack of sensitivity. Increasing the sensitivity of polyclonal EIA tests by using more concentrated immunoreagents or more sensitive enzyme substrates has often resulted in a loss of specificity. A similar problem with sensitivity exists with nucleic acid hybridization techniques. Current tests require 1,000 to 100,000 infectious units of virus for detection, which is similar to that required for EIA. For direct detection of viruses in environmental samples, concentration of the samples is needed with the present level of sensitivity of the nonculture methods. Even with concentration, the ability to detect virus would depend on the sample tested. For example, the number of infectious viruses present in sewage may be in the range of 100 to 1000 or more per liter, whereas river water may contain only 10 or less infectious viruses per liter. For identification of specific virus types, such as rotaviruses, a monoclonal antibody-based EIA test might be suitable. For a more broad-spectrum assay, probes that react with more than one enterovirus type, such as the one for poliovirus described above, may also be applicable to the same kind of samples. Further development and simplification of nucleic acid detection methods are required, however, to be practical for routine use. (See also W89-02111) (Lantz-PTT)
W89-02119

CELL CULTURES AND OTHER HOST SYSTEMS FOR DETECTING AND QUANTIFYING VIRUSES IN THE ENVIRONMENT,
Hadassah Medical School, Jerusalem (Israel). Dept. of Environmental Health.
N. Guttman-Bass.
IN: Methods for Recovering Viruses from the Environment. CRC Press, Inc., Boca Raton, Florida, 1987. p 195-228, 1 tab, 208 ref.

Descriptors: *Pollutant identification, *Microbiological studies, *Culturing techniques, *Viruses, Enteroviruses, Water quality control, Wastewater.

Primary cell cultures are the most sensitive host systems for recovering enteric viruses from environmental waters. It is possible to use continuous lines in place of primary cell cultures, but care must be taken that the subline used is a sensitive one. Careful selection of both a monkey and a human line will maximize the range of viruses detected. Of the lines that have been explored, HeLa-R, BGM, and RD seem to be the best substitutes for primary cultures. More monkey cell lines, such as MA-104 and LLC-MK sub 2, should be tested to determine their usefulness for recovering viruses from wastewater samples. It is possible that future virus recovery systems may include immunochemical assays in combination with cell culture systems. One of the challenges of water virology is the detection of enteric viruses that are not easily recovered in cell culture systems. Moreover, it is a continuing challenge to find reliable, sensitive cell substrates tht cen detect the many cytopathic

human pathogenic viruses in the water environment. (See also W89-02111) (Lantz-PTT)
W89-02120

VARIATION IN QUANTIFICATION OF CONCENTRATIONS OF TOXIC CHEMICALS IN FISH FROM THE LAURENTIAN GREAT LAKES: THE GOOD, THE BAD AND THE MANAGEABLE,
Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 5B.
W89-02122

EFFECTS OF CONTAMINANTS ON ALGAE: AN OVERVIEW,
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Fisheries Research Branch.
For primary bibliographic entry see Field 5C.
W89-02127

EVALUATION OF TOXICITY PROFILES OF ORGANIC CHEMICALS: USEFULNESS OF ECOTOXICOLOGICAL BASIC TEST SET OF OECD,
Chemicals Inspection and Testing Inst., Oita (Japan). Hita Research Labs.
H. Tadokoro, and M. Maeda.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 179-193, 3 fig, 3 tab, 12 ref.

Descriptors: *Toxicity, *Organic compounds, *Water pollution effects, *Pollutant identification, *Toxicology, *Ecotoxicology, *Bioassays, Daphnia, Algae, Fish, Bioaccumulation, Standards.

This study focused on methods of identifying potentially hazardous chemicals using a set of three tests: a growth inhibition test with algae Chlorella vulgaris, an acute an reproduction test with Daphnia magna, and an acute test with fish Oryzias latipes, and their QSARs. Twenty chemicals having a wide range of toxicity and bioaccumulation rates to fish were tested according to the OECD guidelines. The correlations between toxicity of different species as well as toxicity and n-octanol/water partition coefficient (P sub ow) or solubility in water (Sol) were examined. Except for several chemicals, the results showed that: (1) chemicals highly toxic to one species are likely to be highly toxic to others; (2) toxicity values correlate to P sub ow and/or Sol; and (3) chronic toxicity values are approximately 1/10 of acute toxicity values for the same test organism. This suggests that chemicals can be divided into two groups - a general correlation group (GCG) having the same non-specific mode of action to various organisms of which toxicities might have a fairly good correlation to P sub ow and/or Sol, and a non-general correlation group. If the correlations of GCG between toxicity and toxicity, as well as toxicity and P sub ow and/or Sol are standardized by further data and theoretical basis, the concept of GCG will become a practical tool for the evaluation of the danger chemicals represent. (See also W89-02121) (Author's abstract)
W89-02129

EXPERIMENTAL PROCEDURES FOR ENVIRONMENTAL HAZARD ASSESSMENT,
Swedish Environmental Research Inst., Stockholm.
A. H. Neilson.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 285-313, 2 fig, 2 tab, 85 ref.

Descriptors: *Hazard assessment, *Water pollution effects, *Sweden, *Hazardous wastes, Trichloroguaiacol, Computer programs, Environmental effects, Biological studies, Mathematical studies.

A short account is given of procedures used in Sweden for using a permit for discharge of chemicals into aquatic systems. A summary is presented of the information required for an initial hazard assessment and is illustrated with data for 4,5,6-trichloroguaiacol. The limitations in the initial procedures are briefly pointed out, and a summary of a comprehensive research program (ESTHER), designed to examine outstanding issues, is given. AN algorithm is presented for hazard assessment based on laboratory experiments supplemented with limited field data. The results of an investigation of chloroguaiacols are briefly presented and attention drawn to significant features not revealed in initial hazard assessments. Methodological aspects of biological testing procedures are briefly reviewed, and unresolved issues noted. It is concluded that substantial gaps remain in current procedures for assessing environmental hazard, and that environmental acceptability of the risk following discharge of chemicals to the aquatic environment must be based on a monitoring program. (See also W89-02121) (Author's abstract)
W89-02134

RESEARCH NEEDS IN SUPPORT OF THE ASSESSMENT PROCESS,
National Water Research Inst., Burlington (Ontario).
W. M. J. Strachan.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 343-359, 1 fig, 2 tab, 7 ref.

Descriptors: *Research priorities, *Hazard assessments, *Great Lakes, *Water pollution effects, Lethal limits, Toxicity, Fish, Chemical wastes.

In the Great Lakes, assessments are needed for the nearly 1000 chemicals which have been detected. Such assessments must provide protection for all uses and deal with the system as a whole. A brief description of an acceptable sequence of decisions leading to control of a chemical is described; these include identification, preliminary assessment, a number of in-depth assessments leading to a 'final' one and then control if required. A minimum number of data elements are identified to be considered at the preliminary assessment stage where chemicals are being screened for further data development. These elements include: (1) mammalian acute LD50, preferably oral dosing of the rat; (2) aquatic acute LC50 with a sensitive fish species; (3) mutagenicity for two cell lines, including one mammalian; and (4) octanol-water partition coefficient. Others are considered important but not likely to be available nor readily developed at this stage. These include production and release to the environment, and, environmental concentrations. Research to develop all these data are required since the data set of most chemicals is only partially available at present. Research will also be required to clarify issues raised in the preliminary assessment and to permit further, more sophisticated assessments possibly leading to control measures. (See also W89-02121) (Author's abstract)
W89-02136

CHEMICAL PROPERTIES NEEDED TO PREDICT EXPOSURE POTENTIAL,
SRI International, Menlo Park, CA. Chemistry Lab.
T. Mill.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 97-120, 12 fig, 5 tab, 30 ref.

Descriptors: *Chemical properties, *Pollutant identification, Prediction, Classification, Physical properties, Vapor pressure, Volatility, Sorption, Henry's constant, Hydrolysis, Computers.

Information on the several thousand synthetic chemicals often includes only the chemical structure, production level, and (possibly) uses. Exposure ranking of these chemicals will have to rely on minimum information and the application of structure-activity relations (SARs) for properties and transformations. Some quantitative relationships between structure and properties or reactivities (SAR) which can be used as predictors for exposure are indicated. Physical properties which can be predicted from structure include vapor pressure, solubility, Henry's constant, volatility and sorption to sediments. Chemical properties include the rate constants for individual transformation processes such as hydrolysis by acid or base, oxidation and photolysis. SARs for predicting property and rate constants are discussed as is the use of a computer program to calculate rate constants from molecular structure alone. (See also W89-02155) (Author's abstract)
W89-02162

TOXICOLOGY TESTING AS A CONTROL STRATEGY,
Chemical Industry Inst. of Toxicology, Research Triangle Park, NC.
For primary bibliographic entry see Field 5G.
W89-02164

GROUNDWATER MONITORING: AN OVERVIEW FROM FIELD DRILLING TO LABORATORY ANALYSIS,
Keck Consulting Services, Williamston, MI.
C. S. Annett, and E. E. Everett.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 201-210, 1 fig.

Descriptors: *Groundwater quality, *Monitoring, *Water analysis, *Drilling, Soil sampling, Water sampling, Sampling, Water quality control.

Increased awareness concerning the extent and significance of groundwater contamination has prompted the development of reliable techniques to accurately monitor the quality of groundwater. The monitoring process involves many phases ranging from the initial drilling process to the final analysis of a water or soil sample. Each phase of the operation is subject to errors which might result in either the collection of a nonrepresentative sample or contamination of the sample. An overview of the monitoring process and available options and precautions for each phase are presented. (See also W89-02196) (Lantz-PTT)
W89-02209

NATIONAL PESTICIDES IN WELL WATER SURVEY,
Environmental Protection Agency, Chicago, IL. Environmental Services Div.
P. A. Reed.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 253-260, 1 tab, 1 ref.

Descriptors: *Surveys, *Data acquisition, *Water quality, *Groundwater quality, *Pesticides, Wells, Drinking water, Potable water, Computer models.

The Environmental Protection Agency has launched the National Pesticide Survey, a nationwide survey of pesticides in drinking water wells. The reasons for conducting the survey, how the survey will be designed and conducted, and the status of the survey planning effort are explained. Statistical design, analytic methods, health advisories, questionnaire, and pilot study are the five steps of the survey. The first stage, statistical design, has been completed. The DRASTIC groundwater vulnerability indices have been developed, and the pesticide usage data have been compiled for all counties in the United States. County selection has occurred. The lab method development and single lab validation is on schedule. Forth-eight of the 53 health advisories were schedule The remaining five health advisories and the lab methods will be extremely valuable outputs of this project, separate from the survey results themselves. (See also W89-02196) (Lantz-PTT)
W89-02213

TOXICITY ASSAYS AND MOLECULAR STRUCTURE TOXICITY,
Drexel Univ., Philadelphia, PA.
For primary bibliographic entry see Field 5D.
W89-02270

5B. Sources Of Pollution

LEACHING OF CARBOFURAN IN FLOODED FIELD UNDER PUDDLED AND NONPUDDLED CONDITIONS,

Central Rice Research Inst., Cuttack (India). Lab. of Soil Microbiology.
K. Ramanand, M. Sharmila, and N. Sethunathan.
Journal of Environmental Science and Health (B) JPFCD2, Vol. 23, No. 3, p 225-234, June 1988. 1 fig, 2 tab, 7 ref.

Descriptors: *Pesticides, *Puddling, *Leaching, *Groundwater pollution, *Path of pollutants, *Carbofuran, Percolation rate, Insecticides, Soil, Phenols, Rice.

In a field study, a granular formulation of carbofuran was broadcast to the standing water of a flooded, upplanted rice field under puddled and nonpuddled conditions. The residues of carbofuran and the metabolite 7-phenol (2,3-dihydro-2,2-dimethyl-7-benzofuranol) in flood water and in leachates at 15 cm and 30 cm depths were analyzed. In nonpuddled soil, substantial amounts of carbofuran and 7-phenol ware recovered from the leachates at both 15 cm and 30 cm depths. In the puddled field the mobility of carbofuran and 7-phenol was restricted to the top 15 cm and almost negligible at 30 cm depth. The percolation rate in puddled and nonpuddled field was 0.45 cm and 1.35 cm/day, respectively. Leaching of carbofuran was retarded under puddled conditions evidently due to slow percolation rate. (Author's abstract)
W89-01283

HISTORY OF POINT SOURCE CONTROL OF NUTRIENTS IN PENNSYLVANIA AND OTHER CHESAPEAKE BAY STATES: PART I,
For primary bibliographic entry see Field 5D.
W89-01288

RECOMMENDED APPROACH TO THE EVALUATION OF THE ENVIRONMENTAL BEHAVIOR OF PESTICIDES: IUPAC REPORTS ON PESTICIDES, NO. 24,
CIBA-GEIGY A.G., Basel (Switzerland). Agricultural Div.
For primary bibliographic entry see Field 5A.
W89-01296

DETECTION OF DRILLING MUD-BASE OIL IN THE BILE OF TROUT, SALMO GAIRDNERI,
Department of Fisheries and Oceans, St. John's (Newfoundland). Science Branch.
J. Hellou, and A. King.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 1, p 101-107, July 1988. 2 fig, 17 ref.

Descriptors: *Drilling fluids, *Oil pollution, *Fate of pollutants, *Bile, *Toxicity, *Trout, *Bioaccumulation, Biotransformation, Hydrocarbons, Metabolism, Nuclear magnetic resonance, Gas chromatography, Mass spectrometry, Fish, Water pollution.

The gall bladder of Salmo gairdneri acts as a bioconcentrator of metabolites derived from an oil quasi-free of aromatics. Although the components present in the hydrolyzed bile extract could not be individually identified by gas liquid chromatography/mass spectrometry, (due to the absence of identical commercial samples), the chemical constitution of this mixture was partially revealed. Saturated and unsaturated metabolites were detected in the bile of trout exposed to a drilling mud-base oil. Further work is needed to determine if the aromatics present in the bile originate from the aromatic fraction of the oil or are due to metabolic transformations of the cyclohexane type molecules in the oil. (Sand-PTT)
W89-01301

REACTION OF ORGANIC PHOSPHATE ESTERS WITH CHLORINE IN AQUEOUS SOLUTION,
Kitakyushu Municipal Inst. of Environmental Health Sciences (Japan).
S. Ishikawa, and K. Baba.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 1, p 143-150, July 1988. 8 fig, 12 ref.

Descriptors: *Organophosphorus compounds, *Chlorine, *Chlorination, *Path of pollutants, *Water treatment, *Wastewater treatment, Pollutants, Toxicity.

Organic chlorides are produced during chlorination in drinking water supply treatment or wastewater treatment. Some of these chlorination products have been shown to be toxic. This study presents a gas chromatography/mass spectrometry investigation of the reaction of a number of organic phosphate esters--widely used industrial chemicals--with chlorine in aqueous solution. Tributyl phosphate (TBP), tries (2-chloroethyl) (TCEP), trioctyl phosphate (TOP), and tricresyl phosphate (TCP) were purified by distillation under reduced pressure; tris(chloropropyl) phosphate (TCPP) and tris(dichloroporoyl) phosphate (CRP) were used with further purification; and triphenyl phosphate (TPP) was purified by zone refining. OPE degradation involves hydrolysis with soidium hydroxide; the reactions of TOP, TPP, and TCP with chlorine proceeded in alkaline media. Decreases of TCEP and CRP in alkaline media were caused by sodium hydroxide hydrolysis; TBP and TCPP were stable in all pH ranges. Even at a chlorine concentration of 3 mg/l, which is a normal level used disinfection, TOP, TPP, and TCP decreased in the ratios of 5, 3, and 5% in 24 hr. In the cases of TPP and TCP, new peaks were observed on each flame photometric detector gas chromatogram after the chlorination. These peaks were identified by GC/MS; in these mass spectra peaks were identified as those of chlorinated TPP and TCP, in which benzine rings were substituted with 1-3 chlorine atoms. Effects of pH on chlorination, Degradation of the OPE's, relationship between OPE decrease and chlorine concentration, chromatograms of chlorination products, and mass spectra of the chromatogram peaks are figured in this report. (Sand-PTT)
W89-01303

EFFECTS OF CHEMICAL POLLUTANTS AND PHYTOPLANKTON BLOOMS ON THE MARINE BIOLOGICAL RESOURCES OF THE ADRIATIC SEA,
Bologna Univ. (Italy). Ist. di Biochimica.
For primary bibliographic entry see Field 5C.
W89-01307

SEDIMENTS AND POLLUTION IN THE NORTHERN ADRIATIC SEA,
Consiglio Nazionale delle Ricerche, Bologna (Italy). Ist. per la Geologia Marina.
F. Frascari, M. Frignani, S. Guerzoni, and M. Ravaioli.
Annals of the New York Academy of Sciences ANYAA9, Vol. 534, p 1000-1020, 1988. 13 fig, 6 tab, 73 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Toxic wastes, *Italy, *Sediments, *Adriatic Sea, Polychlorinated biphenyls, Metals, Heavy metals, Radionuclides, Nutrients, Coastal waters, Chromium, Mercury, Lead, Zinc, Copper, Cadmium, DDT, Halogenated pesticides, Insecticides, Particulate matter, Silt, Clay, Po River delta, Chlorinated hydrocarbons.

The Po River and some other minor rivers transport toxic chemicals and nutrients from highly developed lands into the Northern Adriatic Sea. It is a shallow semi-enclosed basin with peculiar hydrodynamics, and the water circulation causes a surprisingly fast renewal of the water. Many pollutants interact with particulate matter, mainly silt and clay fractions, which settles in some areas along the northern and western coast of the basin, forming reservoirs with long-term and release potentials. Some chemicals, e.g. toxic metals (Cr, Hg, Pb, Zn, Cu, Cd), chlorinated pesticides (DDT and its analogs), polychlorinated biphenyls, artificial radionuclides and nutrients, show their maximal concentrations in the prodelta areas off riverine mouths, in lagoons and inlets, and near particular waste discharges. The concentrations of these chemicals in the Adriatic sediments are not high when compared to reference data of other marine coastal areas in the world. Most of the knowledge of the behavior of pollutants and particulate matter in the Adriatic is somewhat qualitative and semi-quantitative. A big effort is needed to quantify the sediment-pollutant interactions and the sediment distribution patterns. (Author's abstract)
W89-01308

NITRATE CONTENT IN FRACTURE ZONE GROUNDWATER IN THE HUMID TROPICS AS RELATED TO DEFORESTATION (LA TENEUR EN NITRATES DES NPPES DE FSSURES DE LA ZONE TROPICALE HUMIDE EN RELATION AVEC LES PROBLEMES DE DEFORESTATION),
Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
For primary bibliographic entry see Field 4C.
W89-01309

PHYSICO-CHEMICAL, BACTERIOLOGICAL, AND BIOLOGICAL STUDY OF THE GENEVAN ALLONDON RIVER BASIN (ETUDE PHYSICO-CHIMIQUE, BACTERIOLOGIQUE ET BIOLOGIQUE DE L'ALLONDON GENEVOISE),
Institut d'Hygiene, Geneva (Switzerland).
For primary bibliographic entry see Field 5C.
W89-01314

ORIGIN AND INFLUENCE OF COAL MINE DRAINAGE ON STREAMS OF THE UNITED STATES,
Geological Survey, Richmond, VA.
J. D. Powell.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 2, p 141-152, April 1988. 7 fig, 9 tab, 24 ref.

Descriptors: *Path of pollutants, *Water pollution effects, *Streams, *Mineralization, *Coal mining, *Water quality, *Acid mine drainage, *Water treatment, Hydrogen ion concentration, Sulfates, Manganese, Iron compounds, Acidic water, Bacteria, Oxidation.

Degradation of water quality related to oxidation of iron disulfide minerals associated with coal is a naturally occurring process that has been observed since the late seventeenth century, many years before commencement of commercial coal mining in the U.S. Disturbing coal strata during mining operations accelerates this natural deterioration of water quality by exposing greater surface areas of reactive minerals to the weathering effects of the atmosphere, hydrosphere, and biosphere. Degraded water quality in the temperate eastern half of the U.S. is readily detected because of the low mineralization of natural water. Maps are presented showing areas in the eastern U.S. where concentrations of chemical constituents in water affected by coal mining (pH, dissolved sulfate, total iron, total manganese) exceed background values and indicate effects of coal mining. Areas in the East most affected by mine drainage are in western Pennsylvania, southern Ohio, western Maryland, West Virginia, southern Illinois, western Kentucky, northern Missouri, and southern Iowa. Effects of coal mining on water quality in the more arid western half of the U.S. are more difficult to detect because of the high degree of mineralization of natural water. Normal background concentrations of constituents are not useful in evaluating effects of coal mine drainage on streams in the more arid West. Three approaches to reduce the effects of coal mining on water quality are: (1) exclusion of oxygenated water from reactive minerals, (2) neutralization of the acid produced, (3) retardation of acid-producing bacteria population in spoil material, by application of detergents that do not produce byproducts requiring disposal. These approaches can be used to help prevent further degradation of water quality in streams by future mining. (Author's abstract)

W89-01315

IRRIGATION RELATED ARSENIC CONTAMINATION OF A THIN, ALLUVIAL AQUIFER, MADISON RIVER VALLEY, MONTANA, U.S.A.

Montana Bureau of Mines and Geology, Butte.
J. L. Sonderegger, and T. Ohguchi.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 2, p 153-161, April 1988. 7 fig, 1 tab, 8 ref.

Descriptors: *Water pollution sources, *Alluvial aquifers, *Montana, *Arsenic, *Groundwater pollution, *Irrigation water, Path of pollutants, Wells, Irrigation ditches, Madison River Valley, Aquifers, Contamination.

The arsenic concentration in 13 water samples from wells in the thin, alluvial aquifer of the Madison River Valley, Montana, ranged from 26 to 150 microgram/l. The Madison River, which originates in Yellowstone National Park, has a mean arsenic concentration of 51 microgram/l, based upon very limited sampling in the study area during the main irrigation period. Groundwater arsenic concentration increases down the valley can be best correlated with the intensity of ditch irrigation in this semiarid area. No other sources of dissolved arsenic as concentrated as that of the river water have been identified. Evaporative concentration of river-derived irrigation water is believed to have been the overwhelming factor in the contamination of this shallow aquifer. (Author's abstract)
W89-01316

EFFECT OF THE ENVIRONMENT ON THE HYDROCHEMICAL CHARACTERISTICS OF AN ALLUVIAL AQUIFER FOLLOWING AN EXCEPTIONAL MULTIYEAR DROUGHT (MEDITERRANEAN SEASHORE, HERAULT, FRANCE): PART II. CLIMATOLOGY AND AGRONOMY,

Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
For primary bibliographic entry see Field 2F.
W89-01318

SOLUBILITY RELATIONSHIPS OF ALUMINUM AND IRON MINERALS ASSOCIATED WITH ACID MINE DRAINAGE,

University of Wyoming Research Corp., Laramie. Western Research Inst.
For primary bibliographic entry see Field 5G.
W89-01322

IRON SULFIDE OXIDATION AND THE CHEMISTRY OF ACID GENERATION,

University of Wyoming Research Corp., Laramie. Western Research Inst.
P. J. Sullivan, J. L. Yelton, and K. J. Reddy.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 3, p 289-295, June 1988. 3 fig, 1 tab, 10 ref. Department of Energy Contract DE-AC2085LC11062.

Descriptors: *Path of pollutants, *Waste disposal, *Weathering, *Acid mine drainage, *Minerals, *Pyrite, *Oil shale, Iron compounds, Aluminum compounds, Hydrogen ion concentration, Solubility, Sulfates, Sulfides, Leachates, Water quality.

Acid mine drainage, produced from the oxidation of iron sulfides, often contains elevated levels of dissolved Al, Fe, and SO4 and low pH. Understanding the interaction of these elements associated with acid mine drainage is necessary for proper solid waste management planning. Two eastern oil shales were leached using humidity cell methods. The study used a New Albany Shale (4.6% pyrite) and a Chattanooga Shale (1.5% pyrite). The leachates from the humidity cells were filtered, and the filtrates were analyzed for total concentrations of cations and anions. After correcting for significant solution species and complexes, ion activities were calculated from total concentrations. The activities of Fe(III), Fe(II), Al and SO4 increased due to the oxidation of pyrite. The oxidation of pyrite resulted in a decreased pH and an increased pe + pH (redox potential). The Fe(III) and Fe(II) activities appeared to be controlled by amorphous Fe(OH)3 solid phase above a pH of 6.0 and below pe + pH 11.0. The Fe(III), Fe(II), and SO4 activities reached saturation with respect to FeOHSO4 solid phase between pH 3.0 and 6.0 and below pe + pH 11.0. Below a pH of 3.0 and above a pe + pH of 11.0, Fe(II), Fe(III) and SO4 activities are supported by FeSO4 7H2O solid phase. Above a pH of 6.0, the Al activity showed an equilibrium with amorphous Al(OH)3 solid phase. Below pH 6.0, Al and SO4 activities are regulated by the AlOHSO4 solid phase, irrespective of pe + pH. Under oxidizing conditions with low to high leaching potential, activities of Al and Fe can be predicted on the basis of secondary mineral formation over a wide range of pH and redox. As a result, the long-term chemistry associated with disposal environments can be largely predicted (including trace elements). (See also W89-01322) (Author's abstract)
W89-01323

IMPACT OF MOSUL TEXTILE FACTORY EFFLUENTS ON TIGRIS RIVER WATER QUALITY,

Mosul Univ. (Iraq). Saddam Dam Research Centre.
M. A. Al-Layla, and S. M. Al-Rawi.
Journal of Environmental Science and Health (A) JESEDU, Vol. 23, No. 6, p 559-563, 1988. 2 tab, 10 ref.

Descriptors: *Water pollution source, *Iraq, *Textile mill wastes, *Water pollution prevention, *Tigris River, Biochemical oxygen demand, Suspended solids, Hardness, Alkalinity, Color, Thermal pollution, Industrial wastewater.

The effluents of the Mosue textile factory (MTF) are disposed of directly to the main sewer of the city where they are mixed with other municipal wastewater and flow into the Tigris River without any treatment. The characteristics of these textile wastes were studied in terms of biochemical oxygen demand (BOD), suspended solids, hardness and other parameters. The wastes were generally colored, highly alkaline, high in BOD contents, high in suspended solids and hot. Effluents might contain some chemicals which might be toxic or biologically refracted. In a movement to reduce the pollution load exerted by such industry, a variety of measures were proposed and recommended, including: (1) use of low BOD synthetic detergent for soap; (2) use of low BOD sizes such as carboxymethyl cellulose for the high BOD starch used; (3) recovery of some of the chemicals; (4) recycling of some effluents; (5) use of exact quantities to reduce the quantities of pollutants leaving the MTF; and (6) economies in water use and fixing meters to control the required quantities. (Sand-PTT)
W89-01326

ORGANIC CATION EFFECTS ON THE SORPTION OF METALS AND NEUTRAL ORGANIC COMPOUNDS ON AQUIFER MATERIAL,

Robert S. Kerr Environmental Research Lab., Ada, OK.
D. C. Bouchard, R. M. Powell, and D. A. Clark.
Journal of Environmental Science and Health (A) JESEDU, Vol. 23, No. 6, p 585-601, 1988. 4 fig, 3 tab, 23 ref.

Descriptors: *Aquifers, *Soil, *Sorption, *Organic compounds, *Metals, *Surfactants, *Path of pollutants, Ethylhexadecyldimethylammonium, Groundwater.

Sorption of ethylhexadecyldimethylammonium (EHDDMA+), a large organic cation, and three neutral organic compounds (NOC's) on two low organic carbon aquifer materials was studied using a soil batch equilibration technique. EHDDMA+ competed effectively with metals for exchange sites and EHDDMA+ sorption was accompanied by an equimolar charge desorption of metals. NOC sorption on the aquifer materials was low (K less than or equal to 0.22) which was consistent with the sorbent's low organic carbon content. However, EHDDMA+ sorption increased toluene sorption by two orders of magnitude. The enhanced toluene sorption was due to the hydrophobic surface provided by the hydrocarbon moiety of sorbed EHDDMA+ (Author's abstract)
W89-01328

STUDY OF THE INTERACTIONS BETWEEN ATRAZINE, DIAZINON AND LINDANE WITH HUMIC ACIDS OF VARIOUS MOLECULAR WEIGHTS,

Nebraska Univ.-Lincoln.
R. Saint-Fort, and S. A. Visser.
Journal of Environmental Science and Health (A) JESEDU, Vol. 23, No. 6, p 613-624, 1988. 6 fig, 3 tab, 13 ref.

Descriptors: *Pesticide kinetics, *Herbicides, *Insecticides, *Humic acids, *Soil organic matter, *Path of pollutants, Diazinon, Lindane, Atrazine, Hydrogen ion concentration, Bonding, Ion exchange, Adsorption, Binding isotherms.

Kinetic, complex formation and equilibrium studies of the adsorption of atrazine, diazinon and lindane on humic acids (HA) of various molecular weights (MW) were investigated. There was evidence that on HA with MW > 300,000 daltons, intraparticle diffusion of the adsorbate into the adsorbent particles was the rate limiting process. Complex formation of atrazine with HA was observed on HA with MW < 300,000 daltons with more atrazine being complexed at acid than at alkaline pH. This result was ascribed to the presence of more atrazine molecules in the protonated form. Ion exchange and hydrogen bonding reactions as well as electron transfer were in this case the mechanisms postulated. Equilibrium data of atrazine and lindane adsorbed on all HA fractions were explained by the Freundlich type isotherm whereas diazinon adsorption on HA with MW > 300,000 daltons followed the Langmuir type isotherm. Throughout the investigation, adsorbate-adsorbent interaction was generally higher at pH 3.7 than at 7.0. (Author's abstract)
W89-01330

RADIOACTIVITY IN WATER SUPPLIES,

For primary bibliographic entry see Field 5F.
W89-01352

GROUNDWATER QUALITY BENEATH THE CITY OF LONDON: OVERVIEW AND LONG-TERM CHANGES,

J. A. Payne, W. M. Thomas, J. E. Cooke, and E. English.
Journal of the Institution of Water and Environmental Management, Vol. 2, No. 3, p 305-310, June 1988. 2 fig, 4 tab, 9 ref.

Descriptors: *Water quality, *Groundwater, *London, *England, Reviews, Geology, Aquifers, Boreholes, Pumping, Groundwater level, Organoleptic properties, Chemical properties, Optical properties, Physical properties, Long-term studies.

The quality of groundwater from the chalk beneath the City of London is discussed in relation to the geology and overpumping of the aquifer in the 19th and early 20th centuries. Although there is some uncertainty over the present levels of groundwater beneath the City of London in relation to geological formations, it is likely that the Basal Sands now contain water again in at least some areas. Since the 1930's there have been marked increases in total hardness, magnesium and sulphate which are greater than previously reported. Differences in quality between neigboring boreholes are probably due to factors such as the condition of the borehole linings and local variations in flow patterns within the aquifer. The leaching out of oxidation products is likely to increase with rising water levels, and, where water passes from the sands to the chalk, the composition of the borehole water will continue to be affected. The slow movement of water through the chalk means that groundwater quality is unlikely to return to its natural equilibrium state within the foreseeable future. (Doria-PTT)

W89-01353

LARGE-TIME SATURATED-UNSATURATED WATER AND CONTAMINANT TRANSPORT MODEL IN UNCONFINED AQUIFERS,
Australian Inst. of Nuclear Science and Engineering, Sutherland.
G. Pantelis.
Applied Mathematical Modelling AMMODL, Vol. 12, No. 4, p 362-365, August 1988. 2 fig, 9 ref.

Descriptors: *Path of pollutants, *Hydrologic models, *Solute transport, *Groundwater pollution, *Aquifers, *Model studies, Water pollution, Advection, Saturation, Saturation zone, Aeration zone, Flow, Saturated flow, Water table, Mathematical analysis, Mathematical studies.

A large-time model for the water and contaminant transport in unconfined aquifers is outlined for cases where the vertical averaging of the advection-dispersion equation is valid. The model includes the unsaturated zone which exists above the water table, and a comparative study is made with the similar and widely used model which assumes saturated flow only. An example is given to demonstrate the effects of the unsaturated zone on the horizontal water and contaminant mass transport in the aquifer. (Author's abstract)
W89-01360

MODEL OF RESIDUAL CURRENTS AND POLLUTANT TRANSPORT IN THE ARABIAN GULF,
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Mathematical Sciences.
R. W. Lardner, W. J. Lehr, R. J. Fraga, and M. A. Sarhan.
Applied Mathematical Modelling AMMODL, Vol. 12, No. 4, p 379-390, August 1988. 15 fig, 2 tab, 32 ref.

Descriptors: *Path of pollutants, *Arabian Gulf, *Oil spills, *Model studies, *Coastal waters, Water currents, Solute transport, Winds, Velocity profiles, Waste depth, Mathematical models, Plumes, Dispersion, Simulation.

A pollutant transport model is presented for the Arabian Gulf, with particular relevance to the portion of the Gulf adjacent to the coast of Saudi Arabia. The model has been developed specifically for oil spill simulations, but it can be adapted to other pollutants. The residual currents in this part of the Gulf are dominated by wind-forcing, and part of the model consists of a computation of the mean wind-driven currents for each month. This is achieved by first solving the shallow-water equations (using a finite difference algorithm) for the depth-averaged velocities, and then solving the momentum equations for the vertical velocity profiles. The pollutant transport part of the model includes surface spreading of the slick, evaporation and dispersion into the water column, convection, and both horizontal and vertical dispersion of the pollutant plume. The model is applied to the simulation of a 5,000-barrel surface spill in the Marjan offshore oil field. (Author's abstract)
W89-01361

CHALLENGE OF ACID RAIN,
State Univ. of New York at Albany. Atmospheric Sciences Research Center.
For primary bibliographic entry see Field 5C.
W89-01380

FATE AND PERSISTENCE OF AQUATIC HERBICIDES,
Minnesota Mining and Mfg. Co., St. Paul. Environmental Lab.
K. H. Reinert, and J. H. Rodgers.
Reviews of Environmental Contamination and Toxicology, Vol. 98, p 61-98, 1987. 16 tab, 137 ref.

Descriptors: *Fate of pollutants, *Herbicides, *Aquatic weed control, *Biodegradation, *Weed control, Literature review, Copper sulfate, Diquat, Dalapon.

The herbicides registered for aquatic use may be ranked according to their persistence in aquatic environments. This persistence is a function of the various fate process half-lives. A list of herbicide persistence in moist soils has been published. Similar persistence is expected in aquatic environments because similar fate processes occur in both environments. Several herbicides have been added to this table which were not originally discussed. Choice of an aquatic herbicide should be based on the plant species to be controlled, herbicide effectiveness, water body type (i.e., river, lake), water usage (i.e., potable, irrigation), and ultimately the persistence of the herbicide. The fate and persistence of 14 aquatic herbicides are discussed. It is better to select an effective herbicide having a relatively short environmental persistence, which usually implies less environmental risks and ultimately negligible secondary or nontarget effects. Some herbicides and algicides do not have particularly stringent label restrictions on water use after treatment; however, this lack of restrictions does not imply short environmental persistence. Study of aquatic herbicide fate and persistence demonstrates numerous gaps and great data variability. Quantitative structure-activity relationships can help predict or estimate some values; however, tests designed to elucidate environmental properties of these herbicides are important and necessary steps in judging the environment risk of aquatic herbicide usage. Recent initiatives found in the proposed Federal Insecticide, Fungicide, and Rodenticide Act amendments of 1986 address these gaps. (Author's abstract)
W89-01383

TRICHLOROETHYLENE: WATER CONTAMINATION AND HEALTH RISK ASSESSMENT,
California Dept. of Health Services, Berkeley. Hazard Evaluation Section.
A. M. Fan.
Reviews of Environmental Contamination and Toxicology, Vol. 101, p 55-92, 1988. 9 tab, 173 ref.

Descriptors: *Trichloroethylene, *Chlorinated hydrocarbons, *Toxicity, *Risks, *Sublethal effects, Water pollution, Hazards, Water pollution effects, Carcinogens, Literature reviews, California, United States.

The toxicology of trichloroethylene (TCE) is reviewed with particulate attention given to the selection of data for human health risk assessment. It reviews the extent of TCE water contamination in the U.S. and California, presents a risk assessment of water contamination, and discusses health issues surrounding TCE contamination of water supplies. The primary effects of inhalation exposure to TCE are on the central nervous system. Acute effects in humans were generally associated with inhalation exposure levels ranging from 200-800 ppm and above. Subchronic oral exposure to TCE produced changes in body weight, liver, or kidney in rats or mice at 500 mg/kg/d or above. Chronic effects in humans can occur following prolonged inhalation exposure to TCE concentrations of about 100 ppm, the severity increasing with concentration and time of exposure. These include asthenia, anorexia, headache, memory loss, moodiness, insomnia, parasethesia, and disturbances of the nervous system. TCE has not been shown to be teratogenic. Reproductive and genotoxic effects were reported. TCE was shown to be carcinogenic in mice but not in rats; human data are inconclusive. The carcinogenic potency factor for TCE is 0.02 per mg/kg/d. A theoretical, additional lifetime cancer risk of 0.000001 is estimated to be associated with a TCE concentration in water of about 5 ppb or lower. TCE was one of the most frequently found chemicals in three national surveys of groundwater and drinking water. The highest concentration reported in a recent US EPA survey was 130 ppb. Issues pertinent to TCE exposure from water include the need for more information on dermal adsorption and environmental fate of the chemical. (VerNooy-PTT)
W89-01385

BIOACCUMULATION BEHAVIOR OF PERSISTENT ORGANIC CHEMICALS WITH AQUATIC ORGANISMS,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
D. W. Connell.
Reviews of Environmental Contamination and Toxicology, Vol. 101, p 117-154, 1988. 6 fig, 8 tab, 94 ref.

Descriptors: *Path of pollutants, *Bioaccumulation, *Biological magnification, *Chlorinated hydrocarbons, *Toxicity, Water pollution effects, Organic compounds, Metabolism, Aquatic organisms, Reviews, Literature, Lipophilic compounds, Animal physiology.

The bioaccumulation of lipophilic compounds by aquatic organisms can proceed by two routes: (1) Bioconcentration by uptake of lipophilic compounds directly from the water mass through the gills, or other respiratory surfaces, into the circulatory fluid to be deposited in the fatty tissues of the organism, and (2) biomagnification, which results from the transfer of the lipophilic compounds from food to fatty tissues. Usually bioconcentration is the most relevant process since, irrespective of the mechanism involved, the concentrations that generally occur in fully aquatic organisms are in accord with this mechanism. Physiologically related groups of aquatic organisms having similar respiratory and metabolic characteristics and used in bioaccumulation investigations have been fish, mollusks, daphnids, microorganisms, and polychaetes. With these groups a significant relationship has been found between log K sub B (the bioconcentration factor) and log K sub OW (the octanol-water partition coefficient) for certain lipophilic compounds, allowing the prediction of bioconcentration from the log K sub OW value. Compounds that bioconcentrate in accord with the log K sub B to log K sub OW relationship, have a comparatively high level of biotic stability and are mostly chlorinated hydrocarbons. The general characteristics of the compounds following this relationship can be described as molecular weight < approx. 300, K sub OW 2-6, water solubility 18-0.002 mol/cu m and a very low degree of ionization. Many aspects of the mechanism of bioaccumulation are not well understood. It is likely that aspects of toxicity would be clarified by a better understanding of bioconcentration and biomagnification. (VerNooy-PTT)
W89-01386

PARTITION OF NONIONIC ORGANIC COMPOUNDS IN AQUATIC SYSTEMS,
Geological Survey, Trenton, NJ.
J. A. Smith, P. J. Witkowski, and C. T. Chiou.
Reviews of Environmental Contamination and Toxicology, Vol. 103, p 127-151, 1988. 8 fig, 1 tab, 79 ref.

Descriptors: *Partition models, *Solute transport, *Water chemistry, *Water pollution, *Path of pollutants, *Organic compounds, *Sorption, Organic solvents, Lipids, Dissolved solids, Reviews, Aquatic organisms, Soil contamination, Sediments, Fish, Zooplankton, Model studies, Molecular structure.

The partition model can be used to explain the observed distribution of nonionic organic compounds in the organic phases associated with soil-sediment, dissolved organic matter, and aquatic organisms. For each of these three cases, the primary determinant of the solute's distribution is its solubility in the aqueous and organic phases comprising the specific environmental system. Water solubility and n-octanol-water partition coefficients serve as useful indicators of a solute's tendency to partition into other organic phases. However, the partition model also takes into account additional factors such as the polarity, composition, and molecular size of the solute and the solvent, as well as the presence or absence of other competing sorptive processes. In soil-sediment systems that are saturated by a polar solvent such as water, uptake by partition is much greater than uptake by adsorption. In unsaturated soil systems, uptake by adsorption can become much more significant since an insufficient number of polar solvent molecules are present to occupy all of the surface sites. Nonionic organic solutes also partition between water and the lipid reservoirs of aquatic organisms. Lipid-

normalized bioconcentration data collected for marine zooplankton, guppies, rainbow trout, and catfish were found to be significantly correlated with triolein-water partition coefficients (K sub TW). The resulting log-log plot shows no systematic differences between the four species of aquatic organisms. Partition of nonionic organic compounds also occurs between water and the microscopic environment of dissolved organic matter (DOM). The apparent solubility enhancement of nonionic solutes by DOM is a function of both the polarity and size of the natural organic molecule and the aqueous solubility of the nonionic solute. (VerNooy-PTT)
W89-01387

TOXICITY OF POTASH BRINES TO EARLY DEVELOPMENTAL STAGES OF ATLANTIC SALMON (SALMO SALAR),
Department of Fisheries and Oceans, St. Andrews (New Brunswick). Biological Station.
For primary bibliographic entry see Field 5C.
W89-01396

SUBLETHAL TOXICITY AND ACCUMULATION OF CADMIUM IN TILAPIA AUREA,
Agricultural Coll. of Athens (Greece). Dept. of Applied Hydrobiology.
For primary bibliographic entry see Field 5C.
W89-01398

DETERMINATION OF LEAD IN TREATED CRAYFISH PROCAMBARUS CLARKII: ACCUMULATION IN DIFFERENT TISSUES,
Valencia Univ. (Spain). Dept. of Analytical Chemistry.
A. Pastor, J. Medina, J. Del Ramo, A. Torreblanca, and J. Diaz-Mayans.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 412-418, September 1988. 5 tab, 18 ref.

Descriptors: *Path of pollutants, *Bioaccumulation, *Lead, *Crayfish, *Crustaceans, *Sublethal effects, Water pollution effects, Gills, Heavy metals, Tissue analysis, Lake Albufera, Venezuela.

In 1978, the American red crayfish Procambarus clarkii (Girard) appeared in Lake Albufera (Valencia, Spain), and have reached a high density, producing ecological and agricultural economic problems in rice crops. The crayfish is being fished commercially. This study investigates the accumulation of lead in tissues of the crayfish P. clarkii following short term lead exposure at several sublethal concentrations. Groups of eight adult intermolt crayfish were exposed to 10, 50, or 100 mg Pb/L for 96 hours. The control crayfish showed lead levels ranging from 6.9 +/- 2.8 ppm dry weight in midgut gland to 261 +/- 114 ppm dry weight in the gills. This may be indicative of high lead contamination of Lake Albufera. In the gills, the mean values of lead levels were different among the control-10 mg Pb/L groups and the 50-100 mg Pb/L groups. In control and treated crayfish the highest percent accumulation (with respect to the total amount of lead detected) was present in the gills. Nearly 90% of the lead was present in the gills of crayfish treated with 100 mg Pb/L, whereas the lead content in other tissues was less than 1%. Since the crayfish used as controls in this study appear to be able to accumulate large quantities of lead without apparent lethal consequences, these animals may be potentially toxic and harmful in human and natural food chains. (VerNooy-PTT)
W89-01399

RADON DISTRIBUTION IN DOMESTIC WATER OF TEXAS,
Texas Univ. Health Science Center at Houston. School of Public Health.
I. Cech, C. Kreitler, H. Prichard, A. Holguin, and M. Lemma.
Ground Water GRWAAR, Vol. 26, No. 5, p 561-569, September-October 1988. 10 fig, 1 tab, 36 ref.

Descriptors: *Radon, *Radioisotopes, *Radiation, *Groundwater pollution, *Water pollution sources, *Domestic water, *Texas, Distribution, Water pollution, Geology, Uranium, Radioactivity, Aquifers, Mineralogy.

Domestic water in selected regions of Texas was sampled for radon-222 between 1984 and 1986. A total of 150 samples were taken from wells and taps and the results were mapped. Concentrations of up to 3,300 pCi/l were found in several supplies. Results are discussed and compared with the locations of major aquifers and the geographical distributions of radioactive deposits and mortality from malignant neoplasms of respiratory organs. It is suggested that the anomalous concentrations of alpha-emitting radioisotopes in well water may be caused by external sources (interaction of Tertiary aquifers with salt domes, leaky faults, and uranium-bearing volcanic ashes) and not the bulk mineralogy of the aquifers. This conclusion offers the possibility of avoiding high risk areas when selecting well drilling locations. (Doria-PTT)
W89-01401

FORCED-GRADIENT TRACER TESTS AND INFERRED HYDRAULIC CONDUCTIVITY DISTRIBUTIONS AT THE MOBILE SITE,
Auburn Univ., AL. Dept. of Civil Engineering.
F. J. Molz, O. Gueven, J. G. Melville, J. S. Nohrstedt, and J. K. Overholtzer.
Ground Water GRWAAR, Vol. 26, No. 5, p 570-579, September-October 1988. 9 fig, 5 tab, 17 ref, append. US EPA Contract CR810704-03.

Descriptors: *Groundwater movement, *Path of pollutants, *Hydraulic conductivity, *Tracers, *Test wells, *Aquifers, *Solute transport, *Mobile, *Alabama, Wells, Confined aquifers, Hydraulic properties, Hydraulics, Well hydraulics, Flow, Stratified flow, Advection.

Four single-well tracer tests and a two-well tracer test were performed in a 21-m thick confined granular aquifer at a field site near Mobile, AL to develop a three-dimensional picture of the hydraulic properties of the aquifer. A high hydraulic conductivity zone appears consistently in the bottom third of the aquifer. This result is in agreement with hydraulic conductivity distributions inferred from previous aquifer thermal energy storage experiments at the same site. In some locations, the new tests indicated high hydraulic conductivity zones in the upper third of the aquifer which were not detected in the previous two-well test and single-well tests performed at the same site but at different locations. Despite the three-dimensional spatial variations of hydraulic conductivity indicated by these tests, it was possible to predict the major features of the tracer concentration as a function of time at the withdrawal well in the two-well test by means of an available numerical model assuming perfect stratification at the test site and using a hydraulic conductivity distribution inferred from a single-well test. It is concluded that the study aquifer has an approximately stratified flow field at the test site, and that reliable predictions of solute transport in a real aquifer will depend on a sufficiently detailed knowledge of the major features of the three-dimensional advection pattern in the aquifer. (Author's abstract)
W89-01402

NUMERICAL MODELING OF SALT-WATER INTRUSION AT HALLANDALE, FLORIDA,
GeoTrans, Inc., Herndon, VA.
For primary bibliographic entry see Field 2F.
W89-01408

SIMULATION AND PARAMETER IDENTIFICATION OF MASS TRANSPORT IN GROUND WATER,
Bergakademie Freiberg (German D.R.).
For primary bibliographic entry see Field 2F.
W89-01409

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART III,
For primary bibliographic entry see Field 2E.
W89-01414

FINITE ELEMENT CHARACTERISTIC ADVECTION MODEL,
Rosenstiel School of Marine and Atmospheric Science, Miami, FL. Div. of Applied Marine Physics.
J. D. Wang, S. V. Cofer-Shabica, and J. C. Fatt.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 114, No. 9, p 1098-1114, September 1988. 7 fig, 3 tab, 13 ref. National Park Service Contract CX5004-1097 RS; Dept. of Energy Contract DE-AS05-76EV05163; NSF Grant 0CE85-16132.

Descriptors: *Mixing, *Path of pollutants, *Finite element method, *Advection, *Model studies, *Boundary conditions, *Solute transport, Coastal waters, Salinity, Chemical properties, Numerical analysis.

For advection-dominated transport processes, the traditional numerical techniques for solving the advection-diffusion equation fail because of numerical oscillations. Fractional step solutions, in which the advection and diffusion processes are treated in separate steps, have been proposed as one way of overcoming this problem. Here, a solution to the advection step based on the method of characteristics on a fixed grid is used. Interpolation is achieved with the finite element technique. Linear and quadratic elements are evaluated in terms of artificial diffusion, phase, and other errors. It was found that linear interpolation creates too much numerical diffusion, while the quadratic scheme is reasonably accurate, but under certain conditions generates spurious extrema. A method retaining the accuracy of the quadratic interpolation and eliminating its shortcoming is suggested. Boundary conditions and source loadings are considered in detail. An application of the model to salinity distribution resulting from canal discharges in Biscayne Bay is described. (Author's abstract)
W89-01418

MODELING TURBULENT TRANSPORT IN STRATIFIED ESTUARY,
Hanover Univ. (Germany, F.R.). Inst. fuer Stroemungsmaschinen.
S. Bloss, R. Lehfeldt, and J. C. Patterson.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 114, No. 9, p 1115- 1133, September 1988. 9 fig, 31 ref, 2 append. Deutsche Forschungsgemeinschaft (DFG) Grant SFB 205.

Descriptors: *Path of pollutants, *Mixing, *Diffusion, *Turbulent flow, *Estuaries, *Finite difference methods, *Mathematical models, Model studies, Eddy diffusion, Eddies, Water currents, Viscosity, Physical properties, Rheology, Wind, Case studies, Simulation.

A finite difference mathematical model for the calculation of estuarine flow and transport processes is presented. Due to the emphasis on engineering applications, turbulence closure is formulated on the basis of mixing length and damping functions. The necessary empirical constants were determined from theoretical considerations and from data published in the literature from meteorological, oceanographic, and laboratory experiments, which yielded a set of parameters for eddy viscosity and eddy diffusivity not tuned to a particular system. Similarly, an integral model is derived to account for wind-induced mixing in the case of highly variable meteorological conditions. Application of the model in a case study of the Trave estuary in northern Germany shows its predictive capability. A long-term simulation of 85 days reproduced both total mixing events and strong stratification. The model showed good agreement with the extensive field data. (Author's abstract)
W89-01419

INTERNATIONAL RIVERS RHINE AND MEUSE: RECENT DEVELOPMENTS IN THE FIELD OF THE PROTECTION AGAINST POLLUTION AND OF DRINKING WATER PRODUCTION IN THE NETHERLANDS INCLUDING THE PROBLEMS OF STORAGE AND EUTROPHICATION,
Water Storage Corp., Rotterdam (Netherlands).
For primary bibliographic entry see Field 5F.

W89-01429

URBAN GROWTH AND WATER BORNE DISEASES IN IBADAN,

Nigerian Inst. of Social and Economic Research, Ibadan.

K. Adeniji.

Aqua AQUAAA No.4, p 209-211, 1988. 2 tab, 8 ref.

Descriptors: *Diseases, *Potable water, *Urbanization, *Water Demand, *Developing countries, *Water pollution sources, Path of pollutants, Human diseases, Municipal water, Management planning, Urban planning.

The supply of potable water to Ibadan, Nigeria has become an endemic problem which has forced the inhabitants to obtain water from doubtful sources. The rapidity of the city's growth and the inability of the water supply agency to meet the increasing demand are some of the explanatory variables for the high incidence of water borne diseases in different parts of the city. The institutional problems facing urban managers in developing countries are also discussed. Suggestions are made on ways of tackling the identified problems. The State Government should overhaul the activities of the state water corporation with a view to making it more functional. Deliberate attempts should be made to remove the financial and management constraints which presently inhibit the effective performance of the Corporation. Futhermore, it should embark on forward planning so as th match the ever-increasing demand for potable water within the Ibadan metropolis. Considering the high costs of capital and operating equipment and materials needed for water treatment and distribution, it is suggested that the current obsolete water rates charged by the corporation should be reviewed upwards. All major industrial and commercial consumers of potable water should have their supplies metered, and they should be made to pay the economic costs of the water consumed. Government can slightly subsidize supply of potable water to the low income households, the majority of whom can ill-afford the economic costs of such a facility. This is very important considering the fact that these households are more vulnerable to water-borne diseases than their middle and high income counterparts as earlier discussed in this article. The State Government and all the local governments should embark on well planned public enlightenment programs on the dangers of drinking water from dubious sources, and on the need for proper storage of water. (Hammond-PTT)

W89-01433

CLOUD DROPLETS: SOLUTE CONCENTRATION IS SIZE DEPENDENT,

Washington Univ., Seattle. Dept. of Civil Engineering.

For primary bibliographic entry see Field 7B.

W89-01436

STUDY ON POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS IN RIVERS AND ESTUARIES IN OSAKA BAY IN JAPAN.

Setsunan Univ., Neyagawa (Japan). Faculty of Pharamaceutical Sciences.

H. Miyata, K. Takayama, J. Ogaki, M. Mimura, and T. Kashimoto.

Toxicological and Environmental Chemistry TXECBP, Vol. 17, No. 2, p 91-101, 1988. 2 fig, 5 tab, 8 ref.

Descriptors: *Path of pollutants, *Chlorinated hydrocarbons, *Water pollution sources, *Toxic wastes, *Japan, *Toxicity, Rivers, Estuaries, Mollusks, Mussels, Municipal wastes, Incineration, Sediments, Fly ash.

In order to search for the source of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans in blue mussels in Osaka bay, sediments from Osaka bay and from rivers running near an urban municipal incinerator were analyzed for polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans and polychlorinated biphenyls. The river and estuary sediments were contaminated with polychlorinated dibenzo-p-dioxins at average levels of 9.8 and 12 ppb on the dry basis, polychlorinated dibenzofurans of 7.8 and 5.1 ppb, and polychlorinated biphenyls of 1600 and 1300 ppb, respectively. The two sediments contained similar profiles of specific isomers and congeners of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans. There was also positive correlation between polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran levels in the two specimens as well as fly ash from urban municipal incinerators. The main source of the two chemicals in Osaka bay probably was the fly ash. (Author's abstract)

W89-01440

METAL MULTIVARIATE RELATIONS IN ECOLOGICAL SEGMENTS,

Universidad del Pais Vasco, Bilbao (Spain).

R. Romero, C. Elejalde, and G. Gomez.

Toxicological and Environmental Chemistry TXECBP, Vol. 17, No. 2, p 117-127, 1988. 2 fig, 5 tab, 8 ref.

Descriptors: *Path of pollutants, *Metals, *Heavy metals, *Statistical methods, Ecological distribution, Air pollution, Flora, Mollusks, Sediments, Springs, Factor analysis, Linear multiple regression.

Multivariate statistical methods were used to analyze the metal contents of different ecological segments (air, plants, mollusks, soils, springs) separating macroconstituents (Na, K, Ca, Mg) from heavy metals (Cr, Mn, Fe, Ni, Co, Pb, Cu, Zn, Cd). Factor analysis was a powerful tool showing the relations between the macrocomponents and the classification of segments according to pollution intensity. Linear multiple regression analysis was used to obtain mathematical equations to connect segments and to explain the source of the pollution. Not much information was obtained, however, by the application of linear discriminant function analysis or repeated measurements analysis. (Author's abstract)

W89-01441

LOW LEVELS OF COPPER AND LEAD IN A HIGHLY INDUSTRIALIZED RIVER,

International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).

For primary bibliographic entry see Field 7B.

W89-01442

LOSS OF HALIDE AND SULPHATE IONS FROM MELTING ICE,

University of East Anglia, Norwich (England). School of Environmental Sciences.

P. Brimblecombe, S. L. Clegg, T. D. Davies, D. Shooter, and M. Tranter.

Water Research WATRAG, Vol. 22, No. 6, p 693-700, June 1988. 4 fig, 18 ref, append.

Descriptors: *Snowmelt, *Melting, *Ice chemistry, *Path of pollutants, *Halides, *Solute transport, *Sulfates, Bromides, Chlorides, Iodides, Ions, Fluorides, Artificial ices, Mathematical models.

Artificial ices of known composition were melted under laboratory conditions to monitor the relative ionic composition of the meltwaters. Chloride, bromide, and iodide tend to be lost from the melting ice more readily than fluoride, which is incorporated into the ice grain interior. The presence of ammonium ions further inhibits fluoride loss. Hydrogen ions cause fluoride to be lost as readily as the other halides. Sulfate is lost more rapidly than chloride at environmental concentrations (< 100 micromole/l), but at higher concentrations (approx. 0.01 mole/l) chloride can be lost as readily as sulfate. The composition of meltwater may be described in terms of the mixing of two solutions: (1) intergranular surficial brines with a high solute concentration, which occupy the ice grain boundaries and (2) relatively dilute meltwater derived from the ice grain interiors. Deviations from simple two-component behavior suggest slightly different distributions for the chloride and the sulfate ions in the interfacial region between the brine and the intragranular ice. The melting of such systems was examined using a simple mathematical model. (Author's abstract)

W89-01447

INFLUENCE OF PARTITION COEFFICIENT OF LIPOPHILIC COMPOUNDS ON BIOCONCENTRATION KINETICS WITH FISH,

Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.

D. W. Hawker, and D. W. Connell.

Water Research WATRAG, Vol. 22, No. 6, p 701-707, June 1988. 5 fig, 2 tab, 24 ref.

Descriptors: *Hazardous wastes, *Bioaccumulation, *Bioconcentration, *Fish, *Lipophilic compounds, *Depuration rate, *Partition coefficients, Aquatic animals, Kinetics, Path of pollutants, Mathematical studies, Molecular structure, Mathematical equations, Chlorinated hydrocarbons.

Application of the kinetic theory for the bioconcentration of lipophilic compounds by fish results in the development of a direct linear relationship between the reciprocal of the clearance, or depuration rate constant (1/k2) and a compound's octanol-water partition coefficient (Kow). This relationship is in close agreement with the available experimental data on fish. However, the bulk of the data fall into a range where a significant direct relationship between log 1/k2 and log Kow also is possible and has been previously demonstrated. The 1/k2 to Kow relationship requires the uptake rate constant k1 to reach a maximum 33/hr for fish, instead of increasing with increasing Kow values as required by the log 1/k2 to log Kow relationship. The derived values for the time to achieve equilibrium (teq) indicate a constant time, 2.3 days for fish, for compounds with a Kow less than 1000, increasing to 0.75 yr with compounds having a Kow of 1,000,000. The teq values for superlipophilic compounds (Kow > 1,000,000) can be obtained by extrapolation, but cannot be verified satisfactorily by the limited experimental data available in this range. These data suggest, however, that substantial increases in time may be required. The prediction of the bioconcentration factor from Kow values requires the establishment of equilibrium. In many situations in the laboratory and the aquatic environment, this does not occur, and with compounds having higher Kow values, new relationships are established that depend on the time period of bioconcentration. (Author's abstract)

W89-01448

MASS TRANSPORT TO STREAMBED BIOFILMS,

Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.

G. J. Gantzer, B. E. Rittmann, and E. E. Herricks.

Water Research WATRAG, Vol. 22, No. 6, p 709-722, June 1988. 8 fig, 1 tab, 41 ref. University of Illinois Water Resources Center Project S-098-ILL.

Descriptors: *Biofilms, *Mass transport, *Model studies, *Water quality, *Biodegradation, *Sediment-water interfaces, Organic matter, Gravel, Cobbles, Bed sediment, Self-purification, Velocity, Water currents, Temporal variation, Mathematical models, Interstitial waters.

A mass transfer equation was developed to account for the movement of biodegradable materials from the water column of shallow streams to the biofilm-colonized surfaces of sand-free gravel and cobble streambeds. The equation was developed from a series of well-controlled, batch biodegradation tests performed in an artificial stream with streambeds between 1.5 and 2 rock layers thick. The batch tests determined the sensitivity of substrate flux into the streambed biofilms to short-term changes in water velocity. Experimental results indicated that substrate flux into the cobble-streambed biofilms was more sensitive than flux into the gravel-streambed biofilms to short-term changes in water velocity, and that cobble streambed had faster removal rates. Rates of substrate

removal by both streambeds were much more sensitive to short-term changes in water velocity than would be predicted by previous mass transport models, which only addressed the transport of materials form the water column to the external (exposed) surface of the streambed. This greater than expected sensitivity to changes in water velocity suggests that interstitial biofilms play an important role in determining substrate removal rates in streams with sand-free gravel and cobble streambeds. (Author's abstract)
W89-01449

IN-STREAM NITRIFICATION RATE PREDICTION,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
J. J. Warwick, and P. Shetty.
Water Research WATRAG, Vol. 22, No. 6, p 723-732, June 1988. 5 fig, 9 tab, 41 ref.

Descriptors: *Streams, *Nitrification, *Water quality, *Path of pollutants, *Eutrophication, SNOAP Model, Mass balance, Dissolved oxygen, Nitrogen, Prediction, Kinetics, Model studies, Cycling nutrients.

A complex, simultaneous nitrogen and dissolved oxygen mass balancing program (SNOAP) was used to accurately assess actual in-stream nitrification rate coefficients. These rate coefficients are compared against estimations from observed spatial changes in various bulk fluid nitrogen species concentrations. Total Kjeldahl N change was the most accurate predictor of in-stream nitrification. Proposed nitrification rate coefficient estimation functions have r2 values exceeding 0.90. Performing a complete N and DO mass balance (e.g., the SNOAP model) requires an extensive data base, which may be unattainable in some situations. Expressions are provided that it is hoped may facilitate a relatively quick, inexpensive, and accurate means for assessing the magnitude of in-stream nitrification. (Rochester-PTT)
W89-01450

EFFECTS OF FLUORIDE CONCENTRATION IN SEAWATER ON GROWTH AND FLUORIDE ACCUMULATION BY SYDNEY ROCK OYSTER (SACCOSTREA COMMERCIALIS) AND FLAT OYSTER (OSTREA ANGASI) SPAT,
New South Wales Dept. of Agriculture, Sydney (Australia). Div. of Fisheries.
For primary bibliographic entry see Field 5C.
W89-01452

ARSENIC SPECIATION AND QUALITY OF GROUNDWATER IN A LEAD-ZINC MINE, IDAHO,
Idaho Univ., Moscow. Dept. of Chemistry.
W. M. Mok, J.A. Riley, and C. M. Wai.
Water Research WATRAG, Vol. 22, No. 6, p 769-774, June 1988. 3 fig, 2 tab, 13 ref.

Descriptors: *Arsenic, *Groundwater pollution, *Path of pollutants, *Water pollution sources, *Leaching, *Heavy metals, *Chemical speciation, *Mine wastes, Idaho, Zinc, Lead, Coeur d'Alene Mining District, Coeur d'Alene River, Seasonal variation, Hydrogen ion concentration, Acidic water, Pollutant identification, Oxidation-reduction potential, Leaching, Surface-groundwater relations, Rivers.

The variations of As(V)/As(III) ratio, with respect to metal contents and pH in groundwater of Bunker Hill Mine, near Kellogg, a major lead-zinc mine in the Coeur d'Alene Mining District, Idaho, were studied. A wide range of As concentrations and As(V)/As(III) ratios were observed in the groundwaters collected from this mine. Samples with high As(V)/As(III) ratios generally were acidic (pH <3) and contained elevated metal levels. Seasonal variations in the As species ratio correlated positively with metal contents in water and were attributed to changing in redox environments and leaching of metals by groundwaters. As is less soluble in mine waters with pH >3, and its chemical behavior appears to be controlled by iron hydroxide precipitate. In comparison with Eh measurement by Pt electrode, the As(V)/As(III) ratio seems to be a more sensitive indicator for evaluating the redox status of a groundwater system. As species in the surface waters collected from the Coeur d'Alene River were measured for comparison. (Author's abstract)
W89-01456

LAND FARMING OF RESERVE PIT FLUIDS AND SLUDGES: FATES OF SELECTED CONTAMINANTS,
Oklahoma State Univ., Stillwater.
M. H. Bates.
Water Research WATRAG, Vol. 22, No. 6, p 793-797, June 1988. 6 tab, 9 ref.

Descriptors: *Path of pollutants, *Land disposal, *Oil wastes, *Sludge, *Heavy metals, *Soil contamination, Fate of pollutants, Bioaccumulation, Zinc, Chromium, Barium, Chlorides, Reserve pit fluids, Grass, Solute transport, Soil water, Leaching.

The fates were examined of Zn, Cr, Ba, and chloride in a silt loam and a sandy soil resulting from land farming of slurried reserve pit wastes. The uptake of these pollutants by bermuda grass, soils, and/or the transport of the ions through the soil column was investigated. It was demonstrated clearly by this laboratory study that contaminants added to soils from the land farming of reserve pit fluids were taken up by vegetation and/or transported through the soil column. However, the quantities of metals leached were very small compared to the total metal loading. The extent of transport of Zn and Cr appeared to be a function of soil type, whereas the mobility of Ba and was probably affected by the presence of Cl(-). Chloride added to the soils was transported readily. (Author's abstract)
W89-01460

URBAN RUNOFF AND COMBINED SEWER OVERFLOW,
Calocerinos and Spina, Liverpool, NY.
R. N. DeGuida.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 864-867, June 1988. 39 ref.

Descriptors: *Literature review, *Urban runoff, *Storm runoff, *Combined sewer overflows, *Wastewater disposal, *Nonpoint pollution sources, Hydrology, Runoff, Chemical properties, Water pollution sources, Wastewater treatment, Water pollution effects, Urban areas, Urban hydrology.

Literature published in 1987 on urban runoff and combined sewer overflow is summarized under the following headings: hydrology, runoff characteristics (chemical properties), nonpoint pollution management, control and treatment, and receiving water impacts. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01481

COAL AND COAL MINE DRAINAGE,
Tennessee Valley Authority, Chattanooga. Div. of Air and Water Resources.
For primary bibliographic entry see Field 5G.
W89-01488

NONPOINT SOURCES,
Northwest Colorado Council of Governments, Frisco.
For primary bibliographic entry see Field 5G.
W89-01495

MIXING AND TRANSPORT,
HydroAnalysis, Inc., Acton, MA.
P. Shanahan, and D. P. Galya.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 933-940, June 1988. 142 ref.

Descriptors: *Literature review, *Rivers, *Estuaries, *Coastal waters, *Lakes, *Path of pollutants, Mixing, Solute transport, Plumes, Jets, Hydraulic models, Sediment transport, Water currents, Tracers, Remote sensing, Turbulence, Hydrodynamics.

Literature published in 1987 on mixing and transport of water pollutants is summarized under the following headings: rivers and streams, lakes, estuaries, coastal waters, stratified fluids, and jets and plumes. Currents, sediment transport, hydraulic modeling, resuspension, tracers, remote sensing, turbulence, and behavior of jets are discussed. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01496

GROUNDWATER QUALITY,
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
C. T. Miller, and D. R. Comalander.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 961-978, June 1988. 207 ref.

Descriptors: *Literature review, *Groundwater pollution, *Water pollution control, *Path of pollutants, *Groundwater movement, Hydrodynamics, Chemical reactions, Biodegradation, Viruses, Saline water intrusion, Risk assessment, Monitoring, Remedies, Gases, Diffusion, Sorption, Desorption.

Literature published in 1987 on groundwater quality from the perspective of water pollution control is summarized under the following headings: single-phase systems (hydrodynamics, sorption/desorption, chemical reactions, biodegradation, viruses, salt-water intrusion, remediation, and monitoring), two-phase systems (hydrodynamics, sorption/desorption, vapor phase diffusion, chemical reactions, biodegradation, remediation, monitoring, and risk assessment), and multiphase systems. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01499

THERMAL EFFECTS,
South Carolina Public Service Authority, Moncks Corner.
For primary bibliographic entry see Field 5C.
W89-01500

FATE OF POLLUTANTS,
Environmental Protection Agency, Gulf Breeze, FL. Gulf Breeze Environmental Research Lab.
P. H. Pritchard.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 983-994, June 1988. 176 ref.

Descriptors: *Literature review, *Fate of pollutants, *Chlorinated compounds, *Xenobiotic compounds, *Hydrocarbons, *Pesticides, *Heavy metals, Biodegradation, Chemical reactions, Wastewater treatment, Sedimentation, Monitoring, Ecosystems, Water pollution control.

Literature published in 1987 on fate of pollutants in aquatic systems is summarized under the following headings: chlorinated xenobiotic chemicals, nonchlorinated xenobiotic chemicals, hydrocarbons, pesticides, and heavy metals. Chemical processes, biodegradation, wastewater treatment options, sedimentary processes, and monitoring are discussed. The review aims to include all pertinent, important

and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01501

AQUATIC SEDIMENTS,
Environmental Protection Agency, Chicago, IL. Environmental Services Div.
W. S. Davis, and T. J. Denbow.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 1077-1088, June 1988. 219 ref.

Descriptors: *Literature review, *Sediments, *Pollutant identification, *Dredging, *Paleolimnology, Oxygen demand, Organic carbon, Nutrients, Metals, Radionuclides, Model studies, Sediment transport, Path of pollutants, Fate of pollutants.

Literature published in 1987 on aquatic sediments in relation to water pollution control is summarized under the following headings: methods, biological activity, oxygen demand and organic carbon, nutrients, metals, radionuclides, organics, dredging, and modeling, sediment transport and paleolimnology. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01504

DETECTION AND OCCURRENCE OF WATERBORNE BACTERIAL AND VIRAL PATHOGENS,
Virginia Polytechnic Inst., Blacksburg.
For primary bibliographic entry see Field 5A.
W89-01508

PROCEEDINGS OF THE NWWA/API CONFERENCE ON PETROLEUM HYDROCARBONS AND ORGANIC CHEMICALS IN GROUND WATER-PREVENTION, DETECTION AND RESTORATION.
Houston, Texas. November 17-19, 1987. National Water Well Association, Dublin, OH. 1987. p 578.

Descriptors: *Groundwater pollution, *Oil spills, *Oil recovery, *Water pollution treatment, *Pollutant identification, Water pollution prevention, Water pollution control, Path of pollutants, Organic compounds, Models, Hydrocarbons, Soil contamination, Biodegradation, Cleanup operations.

The National Water Well Association/American Petroleum Institute (NWWA/API) Conference and Exposition on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration, was held in Houston, Texas, on November 17-19, 1987. The conference covered a wide range of topics including prevention of groundwater contamination, treatment levels for groundwater cleanup, hydrocarbon recovery technology, alternative treatment techniques, venting and aeration techniques, biorestoration, monitoring well technology, soil gas sampling techniques, fate and transport of petroleum hydrocarbons and organic chemicals in the vadose zone and groundwater, and biodegradation. Government officials, consulting geologists and engineers, researchers, industry representatives and other interested persons met to learn and discuss state-of-the-art techniques employed in preventing, detecting and restoring groundwater contamination resulting from petroleum hydrocarbons and organic chemicals. Additionally, the latest in state-of-the-art instrumentation and equipment was discussed and displayed. The conference provided a forum for all who attended to communicate and share their experiences in this rapidly developing field. These proceedings are a compilation of papers presented by the symposium speakers. (See W89-01531 thru W89-01563)
W89-01530

COMPARISON OF GROUND WATER CLEANUP LEVELS; TWO CASE HISTORIES,
IT Corp., Monroeville, PA.
For primary bibliographic entry see Field 5G.
W89-01532

USE OF RISK ASSESSMENT TO DEFINE A CORRECTIVE ACTION PLAN FOR LEAKING UNDERGROUND STORAGE TANKS,
Gradient Corp., Cambridge, MA.
For primary bibliographic entry see Field 6E.
W89-01533

INTERPRETATION OF TIDALLY AFFECTED GROUND-WATER FLOW SYSTEMS IN POLLUTION STUDIES,
Geological Survey, Trenton, NJ. Water Resources Div.
M. E. Serfes.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 55-73, 6 fig, 10 ref.

Descriptors: *Path of pollutants, *Groundwater movement, *Groundwater pollution, *Tidal effects, Water table fluctuations, Tidal currents, Flow velocity, Test wells, Aquifers, Pressure distribution, Hydraulic gradient.

Tidal fluctuations in surface-water bodies produce progressive pressure waves in adjacent aquifers. These pressure waves propagate through the aquifer resulting in periodic fluctuations in groundwater elevation. These pressure waves are generated from movement of tidal water into and out of submarine outcrops or by loading and unloading of confined layers. Cyclic groundwater level fluctuations can hamper attempts to determine the direction and velocity of contaminant transport in groundwater using standard methods. Contaminant transport information is critical for the selection of monitor-well locations, for conducting applicable risk assessment analyses and for selecting remedial designs. At any point where groundwater levels cyclically fluctuate the hydraulic gradient varies about a mean value. The velocity and direction of groundwater flow varies throughout the cycle; however, the net effect can be determined from the mean hydraulic gradient. The mean hydraulic gradient can be calculated based on time-weighted averages of groundwater elevations collected throughout a diurnal tidal cycle. Before groundwater elevations are averaged however they must be corrected for barometric pressure effects, if applicable, and long period disturbances in groundwater elevation. A crude estimate of aquifer transmissivity can also be calculated based on the attenuation of a propagating pressure wave as a function of the distance between sampling points within the aquifer. (See also W89-01530) (Author's abstract)
W89-01535

FATE AND TRANSPORT OF RESIDUAL HYDROCARBON IN GROUNDWATER: A CASE STUDY,
Shell Oil Co., Houston, TX.
M. W. Kemblowski, J. P. Salanitro, G. M. Deeley, and C. C. Stanley.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 207-231, 18 fig, 4 tab, 20 ref.

Descriptors: *Path of pollutants, *Hydrocarbons, *Gasoline, *Fate of pollutants, *Groundwater pollution, *Benzenes, Plumes, Water pollution treatment, Cleanup operations, Groundwater movement, Lead, Biodegradation, Dissolved oxygen, Models.

The residual and soluble hydrocarbon behavior at a gasoline leak site was investigated. The study included estimation of the aquifer's hydraulic properties and contamination, laboratory analysis of benzene, toluene, and xylene (BTX) sorption on the soil, analysis of the soil and soluble lead concentrations, and laboratory experiments on benzene biodegradation. These data were then used to model the soluble plume transport at the site. Increases in benzene concentration were observed in the vicinity of the recovery well after the recovery operation terminated. This is attributed to the dissolution of the residual hydrocarbon that was entrapped in the cone of depression during recovery. The areal extent of the plume has not increased significantly due to the apparent establishment of a new equilibrium state between dissolution and biodegradation. The batch equilibrium results for sorption of BTX were described by linear isotherms, and used in the analysis of the transport of soluble benzene plume. Insufficient data were available for determining the influence of gasoline associated lead on soil lead concentrations. Overlap of the leak site with areas receiving lead from automobile exhaust precluded the identification of gasoline lead. The concentration of soluble lead correlates with pH and not soil lead concentration. A threshold may exist for dissolved oxygen (DO) in groundwater (e.g. 0.5 ppm) below which aerobic degradation is reduced and above which transformation is stimulated. Benzene appears to be degraded nearly completely to $CO2$ at concentrations of 50-5000 ppb and groundwater DO levels > 2 ppm. Analysis of conditions of this site indicates that biodegradation of the soluble plume may depend upon the diffusive transport of oxygen from the vadose zone into groundwater. This complex mechanism can be approximated using first-order degradation of soluble hydrocarbon. A macrodegradation rate of 0.85%/day was obtained as a result of this simplified model's calibration. Analysis of data from other sites shows that the first order degradation approximation can be successfully utilized to analyze the fate of soluble hydrocarbon plumes. (See also W89-01530) (Author's abstract)
W89-01543

DETERMINATION OF A REALISTIC ESTIMATE OF THE ACTUAL FORMATION PRODUCT THICKNESS USING MONITOR WELLS: A FIELD BAILOUT TEST,
S and ME, Inc., Atlanta, GA.
T. S. Gruszczenski.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 235-253, 3 tab, 7 ref.

Descriptors: *Pumping tests, *Test wells, *Groundwater pollution, *Path of pollutants, *Oil spills, Graphical methods, Leakage, Storage tanks, Monitoring, Soil types, Oil-water interfaces.

A field test to determine a realistic estimate of the actual formation product thickness as measured in monitor wells is outlined. This empirical test is similar to a rising head slug test. Product that has accumulated in a monitor well is bailed out and the rising water/product levels are recorded with time using an oil/water interface probe. This test has been performed on various sites underlain by residual Piedmont soils of the southeastern United States. The results of this test yield two basic curve types. Type one curves were observed in monitor wells with product accumulation less than several inches. This curve type indicates a one to one correspondence between the measured and actual formation product thickness. Type two curves were observed in monitor wells with product accumulation greater than 12 inches. This curve type indicates an inflection point prior to stabilization of water product levels. This inflection point is the actual equilibrium point during the accumulation of water and product. The stabilized water and product levels recorded represents a pseudoequilibrium caused by the difference in specific gravity and height of capillary fringe. This inflection point indicates a 70% to 95% reduction between the measured and actual formation product thickness. (See also W89-01530) (Author's abstract)
W89-01544

GROUND WATER MONITORING EXPERIENCE AT A REFINERY LAND TREATMENT UNIT,
Total Petroleum, Inc., Ardmore, OK.
For primary bibliographic entry see Field 7A.
W89-01546

DETECTION AND DELINEATION OF A FUEL OIL PLUME IN A LAYERED BEDROCK DEPOSIT,
TRC Environmental Consultants, Inc., Englewood, CO.
For primary bibliographic entry see Field 7A.
W89-01547

USE OF HEADSPACE SAMPLING TECHNIQUES IN THE FIELD TO QUANTIFY LEVELS OF GASOLINE CONTAMINATION IN SOIL AND GROUND WATER,
Connecticut Univ., Storrs. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W89-01548

HYDROCARBON VAPOR PLUME DEFINITION USING AMBIENT TEMPERATURE HEADSPACE ANALYSIS,
ERT, A Resource Engineering Co., Fort Collins, Co.
For primary bibliographic entry see Field 5A.
W89-01549

MULTI DEPTH SOIL GAS ANALYSES,
San Diego State Univ., CA. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5A.
W89-01550

SOIL GAS SURVEY AS A PRELIMINARY INVESTIGATIVE TOOL FOR HYDROCARBON RELEASES: COST-EFFECTIVE FIELD TECHNIQUES AND AN EVALUATION OF FACTORS INFLUENCING THE EFFECTIVENESS OF THE SURVEY,
IEP, Inc., Northborough, MA.
For primary bibliographic entry see Field 5A.
W89-01551

SOIL GAS ANALYSIS OF METHANE AND CARBON DIOXIDE: DELINEATING AND MONITORING PETROLEUM HYDROCARBONS,
For primary bibliographic entry see Field 5A.
W89-01552

LABORATORY SETUP TO STUDY TWO-DIMENSIONAL MULTIPHASE FLOW IN POROUS MEDIA,
American Society for Engineering Education, Washington, DC.
H. O. Schiegg, and J. F. McBride.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 371-395, 13 fig, 1 tab, 21 ref. Department of Energy Contract DE-AC06-76RLO 1830.

Descriptors: *Multiphase flow, *Water pollution sources, *Path of pollutants, *Groundwater pollution, *Mathematical models, *Groundwater movement, Vadose water, Soil porosity, Oil pollution, Porous media, Model studies, Isotope studies.

A lack of experimental data currently hinders the validation of models for two-dimensional multiphase flow in porous media. To close this gap, researchers are building large containers filled with porous media in which to perform oil propagation experiments in simulated vadose and water-saturated zones. The containers are instrumented to yield liquid pressure and fluid saturation data. The quality of these data depends on the researcher's ability to minimize the experimental error contributed by the instrument systems and the container materials. A laboratory setup is described that minimizes these sources of error. A flume was built with inside dimensions of 280 cm in length, 60 cm in height, and 15 cm in cross-sectional width. The front and back walls of the flume consisted of single glass plates to prevent preferential wetting by the oil, as would occur on acrylic plates. A uniform sand with a mean grain diameter of 0.33 mm was carefully applied in 0.15-mm layers with a funnel mounted on an automated cart. The 15-cm width was theoretically calculated to minimize the error in cross-sectional porosity caused by the larger pores next to walls. In addition, to remove the larger pores next to the walls, a fine sand was applied by the automated cart. The variation in porosity with height was smaller than 0.003. Hydrophilic and hydrophobic pressure probes were installed and connected to pressure transducers. The response time of the pressure probe apparatus was less than 0.10 seconds, and the resolution was less than 0.2-mm H2O piezometric head. A dual-energy gamma attenuation system was used to measure fluid saturations across the width of the flume. A 1.0-Ci cesium source (0.662 MeV) and a 2,000-Ci thulium source (0.084 MeV) were used to obtain 10-second counting times with a standard deviation lower than 2% fluid saturation. By minimizing the sources of error, the data obtained from a series of oil propagation experiments performed in the flume are suitable for the preliminary validation of multiphase flow codes. (See also W89-01530) (Author's abstract)
W89-01553

SORPTION AND MIGRATION OF ORGANIC CONTAMINANTS IN SOIL COLUMN,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
A. T. Kan, and M. B. Tomson.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 397-407, 2 fig, 2 tab, 21 ref. EPA Grant CR-812808.

Descriptors: *Benzenes, *Path of pollutants, *Soil columns, *Mathematical models, *Groundwater pollution, *Groundwater movement, Sorption, Solubility, Advection, Organic compounds, Flow rates, Mathematical studies, Soil contamination.

The soil column is used to assess the effect of the aqueous flow rate on the mobility of benzene and toluene. The breakthrough curve can be fitted well by the one dimensional advective-dispersion equation using the Ogata and Banks solution with dispersivity equivalent to 0.5 cm. The retardation factors of benzene and toluene are 1.0 and 1.4. No slow sorption kinetics are observed with the sorption of toluene on the soil of interest. Results show that to predict toluene breakthrough using an estimated partition coefficient calculated from the octanol/water partition coefficient or solubility may lead to an incorrect answer. A new method is proposed to measure the partition coefficient directly from the same soil column as flow experiments at zero flow rate. This approach should eliminate most of the uncertainty of batch experiments. (See also W89-01530) (Author's abstract)
W89-01554

DISSOLUTION OF RESIDUAL DENSE NON-AQUEOUS PHASE LIQUID (DNAPL) FROM A SATURATED POROUS MEDIUM,
Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
M. R. Anderson, R. L. Johnson, and J. F. Pankow.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 409-428, 6 fig, 5 tab, 37 ref.

Descriptors: *Path of pollutants, *Groundwater pollution, *Hydrocarbons, *Model studies, Sand aquifers, Mathematical models, Plumes, Organic compounds, Hydraulic gradient, Water pollution sources, Porous media.

When a non-aqueous phase liquid migrates through a porous medium, a certain amount of that liquid becomes trapped in the pore spaces due to capillary forces. This residual fluid then remains as a source of contamination for water flowing through the medium. Since halogenated hydrocarbons have densities greater than that of water they have the potential to penetrate the water table and leave residual amounts trapped in an aquifer. Studies have shown that when water is passed through a porous medium containing a hydrocarbon residual, the concentration of the dissolved hydrocarbon approaches saturation very quickly. However, these experiments were run in small columns where: (1) hydraulic gradients can be higher than those normally encountered in the field, (2) mobilization of the residual may result from these increased hydraulic gradients, and (3) it is not possible to see if the reduced relative permeability caused by the trapped residual has any effects on the development of the dissolved contaminant plume. In this study, a 75 by 100 by 100 cm tank was constructed to contain a model aquifer consisting of Ottawa sand. A residual source of perchloroethylene (PCE) containing a water insoluble dye was created inside of a 15.2-cm diameter cylinder. After removing the cylinder, water samples were taken at various times from a grid of hypodermic needles that penetrated the sand at the downgradient end of the tank. Gas chromatography was used to determine the dissolved PCE concentrations. Results indicate that: (1) the initial breakthrough of the plume showed very little longitudinal dispersion, (2) after the PCE concentrations stabilized, the values in the center of the plume were near or at saturation (200 ppm), (3) modeling the plume required a source width equal to 89% of the width of the cylinder, and (4) at velocities greater than 60 cm/day the effects of diffusion on plume spreading were no longer visible. Subsequent excavation of the tank and inspection of the dye revealed a source of PCE which did not appear to have been mobilized by the velocities (10-100 cm/day) used in this experiment. (See also W89-01530) (Author's abstract)
W89-01555

BIOPLUME II: TWO DIMENSIONAL MODELING FOR HYDROCARBON BIODEGRADATION AND IN SITU RESTORATION,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
H. S. Rifai, and P. B. Bedient.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 431-450, 7 fig, 3 tab, 26 ref.

Descriptors: *Fate of pollutants, *Biodegradation, *Hydrocarbons, *Groundwater pollution, *Model studies, *Solute transport, Aeration, Plumes, Path of pollutants, Michigan, Model studies, Oxygen, Injection wells, Groundwater movement, Bioplume II Model, Model studies, Hydrologic models.

A two-dimensional model (BIOPLUME II) was developed for a PC/AT to simulate hydrocarbon transport under the influence of oxygen limited biodegradation. The USGS 2-D Solute Transport Model was modified to allow parallel processing of oxygen and hydrocarbon particles at every time step. The reaction between oxygen and hydrocarbon was approximated as an instantaneous reaction since oxygen transport into the plume was shown to be rate limiting. The model incorporates retardation effects and simulates anaerobic biodegradation and oxygen exchange with the unsaturated zone as a first order decay in hydrocarbon concentration. The in situ restoration schemes can be simulated by specifying the location of the injection wells, the rate of injection, and the concentration of oxygen in the injected water. A mass balance computation is performed for oxygen and hydrocarbon, and the amount of mass biodegraded due to aerobic, anaerobic and reaeration processes are computed separately for the hydrocarbon. Sensitivity analyses indicated that the amount of biodegraded mass is most sensitive to hydraulic conductivity, reaeration and anaerobic decay. BIOPLUME II is equipped with a menu-driven preprocessor which provides the user with interactive

data input features as well as graphical output capability. The model has been tested at two field sites where oxygen limited biodegradation is known to occur. Results at Traverse City, Michigan indicate that the model provides a good approximation of field conditions and all the general trends observed in the plume migration. (See also W89-01530) (Author's abstract)
W89-01556

EFFECTS OF DISSOLVED OXYGEN ON THE BIODEGRADATION OF BTX IN A SANDY AQUIFER,

Shell Development Co., Houston, TX.
C. Y. Chai, J. P. Salanitro, J. D. Colthart, and C. L. Klein.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 451-469, 8 fig, 1 tab, 6 ref, append.

Descriptors: *Fate of pollutants, *Dissolved oxygen, *Biodegradation, *Benzenes, *Groundwater pollution, *Path of pollutants, Statistical analysis, Hydrocarbons, Fate of pollutants, Sandy aquifers, Groundwater movement, Mathematical models.

The effect of groundwater dissolved oxygen (DO) levels on the biodegradation of benzene, toluene, and xylene (BTX) at a field site was investigated. An equation was developed to show how the two competitive attenuation processes, natural aerobic biodegradation and volatilization, accounted for the disappearance of benzene in the ground water. Field analyses show that when oxygen is present at concentrations greater than 0.9 ppm, BTX is absent. The relationships between DO and total BTX concentrations in groundwater were evaluated by statistical analyses. A general conclusion from the statistical analyses was made: wells with lower BTX concentrations ($<$ 1 ppm) have significantly higher DO levels ($>$ 1 ppm) than wells containing higher BTX concentrations ($>$1 ppm). In addition, laboratory microcosm biodegradation experiments were performed to determine possible threshold limits for aromatic hydrocarbon oxidation under varying levels of DO. The results were remarkably consistent with field data on the presence of high or low levels of BTX and DO in several monitoring well water samples. (See also W89-01530) (Author's abstract)
W89-01557

NUMERICAL MODELING OF SUBSURFACE CONTAMINANT TRANSPORT WITH BIODEGRADATION KINETICS,

Rice Univ., Houston, TX. Dept. of Mathematical Sciences.
M. F. Wheeler, C. Dawson, and P. B. Bedient.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 471-490, 7 fig, 1 tab, 19 ref.

Descriptors: *Fate of pollutants, *Model studies, *Groundwater pollution, *Mathematical models, *Finite element method, *Biodegradation, *Microbial degradation, Mathematical studies, Hydrocarbons, Dissolved oxygen, Michigan, Model studies, Groundwater movement, Path of pollutants, Well hydraulics.

A comprehensive groundwater contaminant transport model based on a modified MOC and a mixed finite element method has been developed. The MOC is combined with a Galerkin finite element method for the transport equation, and the mixed finite element method solves the flow equation. The crucial aspect of the method is that it looks backward in time, along an approximate flow path rather than forward in time as in the moving mesh technique. Much larger time steps can be taken compared to the Galerkin finite element method with no loss of accuracy. Recently, the model has been expanded to handle microbial biodegradation. The chemical components are handled by a time-splitting method whereby the convection-dispersion terms are combined with the time derivatives and treated as a system of ordinary differential equations. Thus, three equations are solved simultaneously with the method, one for hydrocarbon, one for dissolved oxygen, and one for microbial growth and decay. In this model, called BIOPLUS, the actual biodegradation kinetics can be traced through the solution of the parallel differential equations. BIOPLUS has been tested for several geometries and was found to provide reasonable results under a variety of pumping and injection schemes for hydrocarbon and oxygen, simultaneously. The model allows hydrocarbons to be retarded while oxygen moves at the groundwater velocity from an upstream injection well. The model is being used to help design an injection and pumping biorestoration experiment at Traverse City, Michigan in 1987. The model handles well hydraulics in a very efficient way. (See also W89-01530) (Author's abstract)
W89-01558

MASS TRANSFER OF ORGANICS BETWEEN SOIL, WATER AND VAPOR PHASES: IMPLICATIONS FOR MONITORING, BIODEGRADATION AND REMEDIATION,

Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
R. L. Johnson, C. D. Palmer, and J. F. Keely.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 493-507, 7 fig, 8 ref.

Descriptors: *Fate of pollutants, *Organic compounds, *Biodegradation, *Advection, *Path of pollutants, *Mass transfer, Monitoring, Soil contamination, Groundwater pollution, Mathematical studies, Gasoline, Mathematical models, Model studies.

A series of one-dimensional diffusion and advection experiments were conducted to examine the role of mass exchange between vapor and water phases. The advective flow of vapors through damp sand with a residual of free product was studied to determine how successfully free-product could be removed by vapor pumping. In addition, the movement of vapors in damp sand without free-product present under both diffusive and advective conditions was examined to evaluate the role of mass transfer in vapor movement outside of the free-product zone. Two conclusions can be drawn from the experimental results. First, mass exchange between pore water and pore vapor is sufficiently rapid to be treated as an equilibrium process for most scenarios. Mass transfer between the vapor and liquid phases will probably not limit biodegradation; and prediction of vapor concentration and movement for soil gas monitoring is probably reasonable. Second, the complete removal of residual hydrocarbons from the subsurface may be difficult to achieve in short periods by soil venting, due to the presence of a significant fraction of low-vapor pressure components in gasoline and other complex hydrocarbon mixtures. However, soil venting can be an effective means of removing the volatile components which often contribute most to the problems posed by high subsurface vapor concentrations. An understanding of the physical chemistry occurring during soil venting is important to the efficient application of vapor extraction procedures. (See also W89-01530) (Geiger-PTT)
W89-01559

INFLUENCE OF PORE AIR/WATER EXCHANGE ON THE DIFFUSION OF VOLATILE ORGANIC VAPORS IN SOIL,

Connecticut Univ., Storrs. Dept. of Geology and Geophysics.
G. A. Robbins.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 509-520, 3 fig, 1 tab, 14 ref.

Descriptors: *Soil gases, *Organic compounds, *Path of pollutants, *Mathematical models, *Diffusion coefficient, Groundwater pollution, Monitoring, Soil contamination, Gasoline, Soil water, Soil moisture.

Knowledge of organic vapor diffusion coefficients in soil is important in establishing vapor monitoring systems, and in interpreting data from soil gas surveys. In this study relations were developed that relate diffusion coefficients in moist soil, dry soil and in air, which take into account vapor/water exchange in soil. Calculations were performed to evaluate the influence of pore air/water exchange on the relative magnitude of vapor diffusion coefficients in soil. Constituents analyzed included soluble components of gasoline, and a number of solvents that are commonly found as soil and groundwater contaminants. Major findings from the analyses are the following. Vapor diffusion coefficients decrease in a non-linear fashion as a function of moisture content. The rate of decrease is inversely related to Henry's law constant (expressed in pressure units). The relative rate of vapor diffusion among constituents examined can significantly change as a function of moisture content. This can lead to reversals in relative vapor diffusion rates in moist soil in comparison to that in dry soil and in air. For some constituents, air/water exchange may effectively curtail vapor monitoring and detection. The exchange process can lead to significant vapor separation among constituents as vapors migrate in soil. This may explain, in part, concentration variations observed in conducting soil gas sampling, with respect to different volatile constituents. Use of empirical relations, which only treat tortuosity, to estimate vapor diffusion coefficients for organic constituents in soil may lead to significant overestimates, in light of their air/water exchange tendencies. (See also W89-01530) (Author's abstract)
W89-01560

VADOSE MODEL OF GASOLINE LEAK,

Insitu Consulting, Laramie, WY.
J. W. Murphy, A. C. Bumb, C. R. McKee, and L. A. Eccles.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 521-540, 14 fig, 2 tab, 6 ref, append.

Descriptors: *Vadose water, *Model studies, *Gasoline, *Leakage, *Path of pollutants, *Groundwater pollution, Mathematical models, Storage tanks, Monitoring, Soil contamination, Model studies, Groundwater movement, Hydrologic models.

Gasoline flow in a three-phase porous medium is computed based on a model (VADOSE) for a gasoline underground storage tank (UST) leaking into the vadose zone below the UST crib. Air/gasoline soil characteristic curves (effective saturation vs. capillary pressure) are derived from air/water characteristic curves for the same soils using a linear scaling technique. Boltzmann distribution curve-fitting parameters are computed for the air/gasoline system by multiplying corresponding parameters from air/water systems by scaling factors derived from interfacial tension ratios. Saturation/pressure behavior of gasoline in the three phase (air/gasoline/water) system is related to the two-phase air/gasoline and gasoline/water characteristics through a correspondence procedure. When water is present at residual saturation, gasoline behavior is defined by a single two-phase air/gasoline characteristic, which is readily scaled to the known air/water characteristic and is thus directly subject to analysis by the VADOSE program. The program was run for six different soil types for both leaking gasoline and leaking water. Gasoline moves downward more rapidly in a given soil and spreads less laterally from the point of origin of the leak. (See also W89-01530) (Author's abstract)
W89-01561

ESTIMATES OF CONCENTRATIONS OF SOLUBLE PETROLEUM HYDROCARBONS MIGRATING INTO GROUND WATER FROM CONTAMINATED SOIL SOURCES,

New Jersey Dept. of Environmental Protection, Trenton. Div. of Hazardous Site Migration.
S. K. Stokman.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 541-558, 3 fig, 7 tab, 28 ref.

Descriptors: *Infiltration, *Path of pollutants, *Groundwater pollution, *Aromatic compounds, *Benzenes, *Soil contamination, *Leaching, Cleanup operations, Water pollution treatment, Gasoline, Water pollution sources, Water pollution prevention.

The most toxic components of fuel oils threatening to contaminate groundwater are the aromatics which are relatively soluble in water. These include the volatile organic compounds such as benzene, toluene, xylene (BTX), and others. In order to develop an effective remedial program for soils contaminated with petroleum products, it is essential to define the ultimate fate of these toxic aromatic hydrocarbons in soil and groundwater. This paper discusses water soluble hydrocarbons BTX, ethylbenzene, and naphthalene, likely to leach into groundwater from two different generic types of soil contaminated with petroleum products. Assuming a soil cleanup based on 100 ppm of total petroleum hydrocarbons, concentrations of BTX, ethylbenzene, and naphthalene leaching into groundwater were estimated using flow models for unsaturated and saturated soils. Estimated concentrations of these hydrocarbons in groundwater were then evaluated to determine if they exceeded federal and/or state applicable or relevant and appropriate requirements (ARARs). With the exception of concentrations of benzene from petroleum naphtha, leaded and unleaded gasolines, and waste oils, 100 ppm of total petroleum hydrocarbons as a soil cleanup objective for petroleum products results in groundwater concentrations of BTX, ethylbenzene, and naphthalene below ARARs. For those constituents in groundwater exceeding ARARs, soil cleanup strategies and levels which reduce the health risks to acceptable levels, are proposed. (See also W89-01530) (Author's abstract)
W89-01562

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON SUBSURFACE INJECTION OF LIQUID WASTES.
For primary bibliographic entry see Field 5E.
W89-01564

DEEPER PROBLEMS: LIMITS TO UNDERGROUND INJECTION AS A HAZARDOUS WASTE DISPOSAL METHOD,
Natural Resources Defense Council, Inc., New York.
For primary bibliographic entry see Field 5E.
W89-01565

SUBSURFACE INJECTION IN ONTARIO, CANADA,
Underground Resource Management, Inc., Austin, TX.
For primary bibliographic entry see Field 2F.
W89-01582

HYDROGEOLOGY OF SEDIMENTARY BASINS AS IT RELATES TO DEEP-WELL INJECTION OF CHEMICAL WASTES,
Texas Univ. at Austin. Bureau of Economic Geology.
For primary bibliographic entry see Field 2F.
W89-01583

APPLICATION OF FLOW, MASS TRANSPORT, AND CHEMICAL REACTION MODELING TO SUBSURFACE LIQUID INJECTION,
Prickett (Thomas A.) and Associates, Urbana, IL.
For primary bibliographic entry see Field 5E.
W89-01585

COMPARISON OF ANALYTICAL AND NUMERICAL METHODS FOR EVALUATING CROSS-FORMATIONAL FLOW AND SELECTING THE PREFERRED INJECTION AQUIFER, SWAN HILLS, ALBERTA, CANADA,
Alberta Research Council, Edmonton. Basin Analysis Group.
For primary bibliographic entry see Field 2F.
W89-01587

FLOW AND CONTAINMENT OF INJECTED WASTES,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
For primary bibliographic entry see Field 5E.
W89-01589

CHEMICAL FATE OF INJECTED WASTES,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
N. C. Scrivner, K. E. Bennett, R. A. Pease, A. Kopatsis, and S. J. Sanders.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 560-609, 36 fig, 13 tab, 91 ref, 9 append.

Descriptors: *Injection wells, *Wastewater disposal, *Disposal wells, *Fate of pollutants, *Computer models, Dolomite, Path of pollutants, Hydrolysis, Ion exchange, Adsorption, Hazardous wastes, Microbial degradation, Precipitation, Sandstones.

The chemical fate of wastes put into disposal wells can be determined using standard chemical engineering techniques. The concentration of hazardous constituents is typically reduced by reactions within the waste itself or by reactions with the injection zone material, thus reducing any potential impact on the environment. Such reactions include neutralization, hydrolysis, ion exchange, adsorption, precipitation, coprecipitation, and microbial degradation. Extensive research was done to quantify these phenomena, so they could be used in a predictive model. Neutralization, hydrolysis, and precipitation were modeled using data from the open literature: reaction rates and equilibrium constants for the dominant reactions were incorporated into a sophisticated computer simulation that calculates solid-liquid equilibria of aqueous electrolyte solutions. The model predicted the fate of two waste streams: (1) high-pH, cyanide-containing waste injected into sandstone is made less hazardous by hydrolysis and sand dissolution, and (2) FeCl3-FeCl2-HCl-H2O waste is made nonhazardous by reaction with dolomite. Experiments are planned to confirm certain model predictions. Further development and public availability of the model are planned. (See also W89-01564) (Author's abstract)
W89-01590

DEEP-WELL INJECTION OF AQUEOUS HYDROCHLORIC ACID,
Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5E.
W89-01591

ROLE OF THE CRITICAL TEMPERATURE OF CARBON DIOXIDE ON THE BEHAVIOR OF WELLS INJECTING HYDROCHLORIC ACID INTO CARBONATE FORMATIONS,
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5E.
W89-01592

SUBSURFACE DISPOSAL OF LIQUID LOW-LEVEL RADIOACTIVE WASTES AT OAK RIDGE, TENNESSEE,
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 5E.
W89-01593

FOCUS ON RESEARCH NEEDS,
Texas Univ. at Austin.
For primary bibliographic entry see Field 5E.
W89-01597

INTERPRETATION OF IN SITU GROUNDWATER QUALITY FROM WELL SAMPLES,
For primary bibliographic entry see Field 7C.
W89-01605

ROLE OF AQUATIC MACROPHYTES IN NUTRIENT FLOW REGULATION IN LOTIC ECOSYSTEMS,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
B. H. Hill.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 157-167, 3 fig, 3 tab, 55 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Agricultural runoff, *Agricultural runoff, *Macrophytes, *Nutrients, Nitrogen, Phosphorus, Cycling nutrients, Fluvial sediments, Biomass, Nitrates, Phosphates.

Aquatic macrophytes in an agricultural drainage ditch were able to accrue large amounts of nitrogen (N) and phosphorus (P) during the growing season and hold these nutrients until tissue breakdown in autumn. Total nutrient accumulation by aquatic macrophytes in a 1.4 km (8612 sq m) ditch was 49.0 kg N (5.65 mg N/sq m) and 11.0 kg P (1.29 mg P/sq m). Release of these nutrients upon tissue breakdown was rapid. Average breakdown rates, based on ash-free dry mass (AFDM) loss, for Elodea canadensis and Potamogeton nodosus were 0.0615 + or - 0.0450/day and 0.0260 + or - 0.0170/day, respectively. Time required for 95% loss of plant tissue was 49.0 days for Elodea and 116.9 days for Potamogeton. Nitrogen and phosphorus losses from decaying plants closely followed AFDM losses. Mass balances for N and P indicated the 94% of the N and 72% of the P accumulated by aquatic macrophytes were obtained from surface sediments. Sediment N and P pools were 864 kg and 62 kg, respectively. (See also W89-01599) (Author's abstract)
W89-01610

PERMEABILITY OF CLAY TO ACIDIC AND CAUSTIC PERMEANTS,
Missouri Univ., Rolla.
R. W. Lentz, W. D. Horst, and J. O. Uppot.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 127-139, 5 fig, 3 tab, 11 ref.

Descriptors: *Liners, *Water pollution sources, *Permeability, *Clays, *Clay minerals, Soil properties, Hydrogen ion concentration, Soil porosity, Acids, Hazardous wastes, Waste disposal, Montmorillonite, Bentonite, Kaolinite.

Results of a laboratory study of the effects of acidic and caustic permeants upon the permeability of various fine-grained soils are reported. Triaxial falling head permeability tests were performed on specimens of kaolinite, kaolinite-bentonite mixture, and magnesium montmorillonite. Permeants used were hydrochloric acid with pH values of 1,3, and 5 and water and sodium hydroxide with pH values of 9, 11, and 13. In no case for any of the clays or permeant pH did the permeability increase during the passage of six pore volumes of permeant, which indicates that no significant dissolution of clay minerals occurred. The only permeant that caused significant change in permeability was sodium hydroxide at a pH of 13, which caused a reduction in permeability of the magnesium montmorillonite by a factor of 13. This was found to be due to precipitation of magnesium hydroxide in the pores. Results are compared with findings reported by other researchers. It is concluded that because of the wide variety of reactions possible between clays and permeant, future reports of permeability changes should give as much detail as possible about the chemistry and mineralogy of the soil studied. The equipment used and testing technique

also have significant effects on reported tests results and should be described in detail. Also, it is suggested that research is needed into possible reactions which could be induced within the soil pores to create favorable changes in permeability. (See also W89-01612) (Author's abstract)
W89-01621

LABORATORY COMPARISON OF THE EFFECTS OF WATER AND WASTE LEACHATE ON THE PERFORMANCE OF SOIL LINERS,
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 8D.
W89-01625

EFFECT OF ORGANIC FLUIDS ON THE PORE SIZE DISTRIBUTION OF COMPACTED KAOLINITE,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W89-01626

EFFECTS OF BRINE ON THE SOIL LINING OF AN EVAPORATION POND,
Bureau of Reclamation, Denver, CO.
C. W. Jones.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 213-228, 6 fig, 16 ref.

Descriptors: *Liners, *Water pollution sources, *Brines, *Clays, *Permeability, *Evaporation ponds, Linings, Soil compaction, Soil properties, Seepage control, Reservoir evaporation, Soil tests.

Information is needed concerning the long-term effects of brine on the permeability of clay linings for salt-gradient solar and salt evaporation ponds. A case history is presented for the soil lining at Anderson Lake, New Mexico, which was operated as a brine evaporation pond from 1963 to 1976. The soil lining was sampled and tested in March 1982. At that time, the brine level was below the deposited salt surface and near the top of the lined area in the lake. From a comparison of the 1982 tests on the lining and preconstruction tests in 1962, the soil density appears to have increased slightly since lining construction, possibly due to effects of the brine on the soil. From approximate measurements of the drop in brine surface in 1982, the seepage through the lining appeared to be very low and was approximately one order of magnitude below the seepage determined during the first year of pond operation. (See also W89-01612) (Author's abstract)
W89-01627

INTERACTIONS BETWEEN ACIDIC SOLUTIONS AND CLAY LINERS: PERMEABILITY AND NEUTRALIZATION,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 8D.
W89-01628

DESIGN AND TESTING OF A COMPACTED CLAY BARRIER LAYER TO LIMIT PERCOLATION THROUGH LANDFILL COVERS,
Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-01629

DESICCATION CRACKING OF SOIL BARRIERS,
Hart Crowser, Inc., Seattle, WA.
J. H. Kleppe, and R. E. Olson.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 263-275, 7 fig, 1 tab, 3 ref.

Descriptors: *Water pollution sources, *Liners, *Clays, *Soil compaction, *Sand, Soil properties, Soil mechanics, Permeability, Leakage, Leaching, cracks, Drying, Linings.

Compacted soil liners have been used to retard leakage of fluids from burial sites. If allowed to desiccate, such liners may shrink, crack, and lose their integrity. As a result of the expense and control problems associated with field tests, an initial laboratory study was made of shrinkage, cracking tendency, and hydraulic conductivity of various compacted clay/sand mixtures. The study showed that desiccation shrinkage increased linearly with compaction water content and was unaffected by density. Soaking prior to desiccation increased strains markedly for specimens compacted dry of optimum. Shrinkage strains greater than 10% should cause serious problems in the field. Clay/sand mixtures were prepared which were crack resistant and which had low hydraulic conductivities. (See also W89-01612) (Author's abstract)
W89-01630

LEACHING TEST CHARACTERIZATION OF IRON AND STEEL INDUSTRY WASTE,
Thyssen A.G., Duisburg (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W89-01635

COMPARISON OF LEACHATE QUALITY IN FOUNDRY WASTE LANDFILLS TO LEACH TEST ABSTRACTS,
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
R. K. Ham, W. C. Boyle, and F. J. Blaha.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 28-44, 3 fig, 7 tab, 4 ref.

Descriptors: *Leachates, *Waste characteristics, *Metal finishing wastes, *Sampling, *Water analysis, *Landfills, Heavy metals, Aeration zone, Water quality, Industrial wastes, Leaching, Wisconsin, Lysimeters.

The landfills for six ferrous foundries in Wisconsin were instrumented with suction lysimeters to sample leachate directly from the waste above the zone of saturation. All landfills disposed of only foundry process solid wastes had minimal known changes in processes and waste over the period of landfilling in the areas tested and were not located in groundwater. The quality of leachate from the lysimeters was compared to the quality of leachate obtained by laboratory leach testing of the auger cuttings obtained during lysimeter installation and to leach tests performed on composite raw waste samples obtained directly from the foundries. It is concluded that, even though the (EP) acid) test was able to predict the presence or absence of a contaminant in landfill leachates over half of the time, the test was inaccurate, in some cases grossly inaccurate, in predicting the actual field concentrations. It is also concluded that the EP (water) test was basically equal to the EP (acid) test in being able to predict the presence or absence of a contaminant in landfill leachates. (See also W89-01634) (Author's abstract)
W89-01636

TESTING METHODOLOGIES FOR LANDFILL CODISPOSAL OF MUNICIPAL AND INDUSTRIAL WASTES,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
F. G. Pohland, and J. P. Gould.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 45-62, 10 fig, 3 tab, 6 ref.

Descriptors: *Water analysis, *Industrial wastes, *Waste disposal, *Municipal wastes, *Landfills, *Heavy metals, Land disposal, Path of pollutants, Leachates, Recycling, Waste-assimilative capacity, Testing procedures, Sludge disposal, Sulfides, Carbonates.

The results of a two-year pilot-scale investigation on codisposal of an industrial metal treatment sludge with municipal refuse under the influence of leachate containment and recycle are used to reveal the environmental consequences of heavy metals on such a landfill management practice. Comparisons between landfill simulators with and without varying metal sludge admixtures have provided an opportunity for examination of selected testing methodologies and parameters descriptive of inherent physical-chemical and microbially mediated reactions prevailing throughout the progress of landfill stabilization. Collectively, these analyses were sufficient to determine landfill assimilative capacity in terms of several controlling mechanisms including: potential inhibition of waste stabilization by mobilized heavy metals; precipitation, immobilization, and detoxification of heavy metals by entrapment and filtration; encapsulation and isolation of heavy metals by reaction with carbonates and sulfides; and formation of less toxic transport phase regulation. On the basis of these results, a method for the determination of sludge loadings and their effects at both present and future landfill codisposal sites could be proposed. (See also W89-01634) (Author's abstract)
W89-01637

APPROACH FOR EVALUATING LONG-TERM LEACHABILITY FROM MEASUREMENT OF INTRINSIC WASTE PROPERTIES,
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
For primary bibliographic entry see Field 5A.
W89-01638

USE OF AN UPFLOW COLUMN LEACHING TEST TO STUDY THE RELEASE PATTERNS OF HEAVY METALS FROM STABILIZED/SOLIDIFIED HEAVY METAL SLUDGES,
Army Environmental Hygiene Agency, Aberdeen Proving Ground, MD. Waste Disposal Engineering Div.
For primary bibliographic entry see Field 5A.
W89-01639

LEACHATE MIGRATION THROUGH CLAY BELOW A DOMESTIC WASTE LANDFILL, SARNIA, ONTARIO, CANADA: CHEMICAL INTERPRETATION AND MODELLING PHILOSOPHIES,
University of Western Ontario, London. Geotechnical Research Centre.
R. M. Quigley, and R. K. Rowe.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 93-103, 9 fig, 1 tab, 7 ref.

Descriptors: *Leaching, *Clays, *Landfills, *Linings, *Waste disposal, *Path of pollutants, Model studies, Sodium, Potassium, Calcium, Magnesium, Chlorine, Mathematical models, Ontario, Groundwater movement, Solute transport, Heavy metals, Iron, Lead, Zinc, Copper.

The results of field and laboratory investigations of a domestic waste landfill overlying 30 m of natural clay are presented. Four study phases extending over a ten-year period are summarized. Concentration profiles for several soluble constituents (sodium, potassium, calcium, magnesium, chloride ion, and dissolved organic carbon) show migration to a maximum depth of approximately 1.5 m in 15 years. This compares to an advective or seepage advance estimated to be only 3 to 5 cm, indicating migration primarily by diffusion. Concentration profiles for the heavy metals (iron, lead, zinc, and copper) indicate rapid field attenuation with migration to only 10 cm in the carbonate-rich clayey soil. Graphed solutions to the coupled advection/diffusion equation using constant values for influent concentration, diffusion coefficient, and average linearized seepage velocity are only partially successful in predicting the observed chemical profiles because of apparent chemical partitioning at the waste/clay interface. A better fit is obtained by employing an artificial effective interface about 25 cm above the observed interface; however, this does not resolve the interface problems. Recently, new analytical and numerical procedures have been developed for modelling this and other contaminant migration problems. These techniques automatically take into account time-dependent concentration variations within the landfill (for

example, because of mass transport into the soil) and allow for a sharp drop in concentration because of surface effects (such as surface smear, drying, and interface partitioning). The numerical solution allows consideration of the effects of a thin but finite interface layer with properties different from those of the underlying soil. Both of these techniques are used in the field case resulting in much superior predictions than earlier models. (See also W89-01634) (Author's abstract)
W89-01640

PENTACHLOROPHENOL ADSORPTION ON SOILS AND ITS POTENTIAL FOR MIGRATION INTO GROUND WATER,
Missouri Univ., Columbia. Dept. of Civil Engineering.
S. K. Banerji, K. Piontek, and J. T. O'Connor.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 120-139, 9 fig, 5 tab, 18 ref.

Descriptors: *Pentachlorophenol, *Adsorption, *Path of pollutants, *Hazardous wastes, *Groundwater pollution, Hydrogen ion concentration, Organic matter, Herbicides, Leaching, Soil absorption capacity, Missouri.

The adsorption of pentachlorphenol (PCP) on Missouri soils was studied in laboratory batch adsorption experiments to determine its potential for migration into groundwater. The adsorption data obtained, using low concentrations (0.1 to 10 mg/L) of PCP, fit the Freundlich isotherm form. PCP, a weak organic acid, was found to adsorb more completely to Missouri soils as pH decreased, converting PCP to its acid form. High soil organic content was found to strongly increase PCP adsorption. However, most (84%) of the PCP adsorption was reversible. Overall, at the pH values observed (5.7, 6.7), Missouri soils would be expected to retard the movement of pentachlorphenol through adsorption. (See also W89-01634) (Author's abstract)
W89-01642

SORPTION KINETICS OF COMPETING ORGANIC SUBSTANCES ON NEW JERSEY COASTAL PLAIN AQUIFER SOLIDS,
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
C. G. Uchrin, and J. Katz.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 140-150, 6 fig, 7 tab, 21 ref.

Descriptors: *Sorption, *Phenols, *Benzenes, *Path of pollutants, *Groundwater pollution, *Industrial wastes, Soils, Aquiferd, Leachates, Adsorption, Kinetics, Mathematical models.

Batch rate and equilibrium experiments were conducted to examine the sorption characteristics of a mixed solute system consisting of para-dichlorobenzene (p-DCB) and 2,4-dichlorophenol (2,4-DCP) to solids from two New Jersey coastal plain aquifer systems. Results were compared to previously reported results obtained for single solute systems. The p-DCB effected a slight enhancement on the 2,4-DCP sorption to the Potomac-Raritan-Magothy (PRM) aquifer solids rather than an inhibitory effect. This was also noted for the adsorption of p-DCB on the Cohansey aquifer solids in the presence of 2,4-DCP. The other systems (2,4-DCP on the Cohansey aquifer solids in the presence of p-DCB and p-DCB on the PRM aquifer solids in the presence of 2,4-DCP) exhibited indiscernible competitive effects. The aquifer solids with the larger organic content adsorbed more of each substance. The data obtained using the more homogeneous aquifer solids evidenced less scatter. (See also W89-01634) (Author's abstract)
W89-01643

USE OF FLEXIBLE MEMBRANE LINERS FOR INDUSTRIAL AND HAZARDOUS WASTE DISPOSAL,
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W89-01645

MIGRATION OF LEACHATE SOLUTION THROUGH CLAY LINER AND SUBSTRATE,
McGill Univ., Montreal (Quebec).
R. N. Yong, M. A. Warith, and P. Boonsinsuk.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 208-225, 14 fig, 5 tab, 11 ref.

Descriptors: *Liners, *Leachates, *Path of pollutants, *Clays, *Linings, *Waste disposal, *Landfills, Municipal wastes, Leaching, Organic matter, Heavy metals, Salts, Theoretical analysis, Chlorides, Performance evaluation.

The migration of various contaminants in a sensitive soil, used as liner and in-situ substrate in an actual landfill site, is investigated in controlled laboratory column leaching tests. Using the actual leachate collected from the site the laboratory tests show good attenuation of the heavy metals studied and lesser attenuation of the salts. Comparison between predicted and concentration profiles, using chloride as an example, shows that there is significant need to account for the time and spatial variation of the specific dispersion coefficients, caused by continued leaching or intrusion of the contaminants, if proper accord between predicted and measured profiles is to be achieved. (See also W89-01634) (Author's abstract)
W89-01646

EFFECT OF PORE FLUID PH ON THE DYNAMIC SHEAR MODULUS OF CLAY,
Lehigh Univ., Bethlehem, PA. Environmental Geotechnology Lab.
For primary bibliographic entry see Field 8D.
W89-01647

REMOTE SENSING METHODS FOR WASTE SITE SUBSURFACE INVESTIGATIONS AND MONITORING,
Office of Radiation Programs, Las Vegas, NV.
For primary bibliographic entry see Field 7B.
W89-01648

RESULTS OF AN INTERLABORATORY STUDY OF A COLUMN METHOD FOR LEACHING SOLID WASTES,
Western Michigan Univ., Kalamazoo.
R. A. Miner, C. Van Maltby, and L. R. Dell.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 375-389, 4 fig, 5 tab, 16 ref.

Descriptors: *Leaching, *Solid wastes, *Fly ash, *Testing procedures, Lysimeters, Leachates, Waste disposal, Metals, Standard deviation, Column method.

A method for generating aqueous leachates from solid wastes in a column apparatus has been drafted by ASTM Subcommittee D34.02.02 on Column Extraction Methods. The method was subjected to a five-laboratory study using fly ash as a waste material. The within laboratory relative standard deviation for metals (based on the results from three laboratories with multiple columns) was approximately 35%. The overall single test reproducibility in terms of relative standard deviation (based on the results from these same laboratories) was approximately 55%. This excludes inter-laboratory analytical effects because all analyses were performed by a central laboratory. (See also W89-01634) (Author's abstract)
W89-01657

BATCH TYPE 24-H DISTRIBUTION RATIO FOR CONTAMINANT ADSORPTION BY SOIL MATERIALS,
Illinois State Geological Survey Div., Champaign. Geochemistry Section.
For primary bibliographic entry see Field 7B.
W89-01658

HAZARDOUS WASTES IN GROUND WATER: A SOLUBLE DILEMMA.
Alberta Research Council, Edmonton.
For primary bibliographic entry see Field 2F.
W89-01661

ROLE OF MASS TRANSPORT MODELING,
Alberta Univ., Edmonton. Dept. of Geology.
F. W. Schwartz, G. L. McClymont, and L. Smith.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 2-12, 8 fig, 23 ref, append.

Descriptors: *Groundwater pollution, *Groundwater movement, *Expert systems, *Model studies, *Path of pollutants, *Mass transfer, Geohydrology, Mathematical models, Computer models, Contamination.

Mass transport models have proven to be of tremendous importance in dealing with applied and theoretical problems in hydrogeology. These range from analytical models involving a single component to multicomponent or multiphase models based on numerical solutions. Whatever the method of solution, the purpose of these models is the same, namely to describe the spread of mass in the subsurface under the influence of physical, chemical and biological processes. By discussing a series of studies, it is easy to demonstrate the applicability of models to practical problems. The most important new trend in modeling is not in the development of more sophisticated models but in the enhancement of individual capabilities through computers. One of the most promising new developments are software programs known as expert systems specifically designed to extend human capabilities. Preliminary work in this area suggests that this application will be particularly useful for problems in contaminant hydrogeology. (See also W89-01661) (Author's abstract)
W89-01662

INTERACTION OF CLAY AND INDUSTRIAL WASTE: A SUMMARY REVIEW,
McGill Univ., Montreal (Quebec). Geotechnical Research Centre.
R. N. Yong.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 13-25, 8 fig, 3 tab, 35 ref. NSERC grant A-882.

Descriptors: *Clays, *Soil chemistry, *Soil physics, *Path of pollutants, *Soil contamination, *Leachates, *Industrial wastes, *Chemical wastes, *Liquid wastes, Diffusivity, Kinetics, Buffering capacity, Hazardous materials.

This review of some of the complex interactions established between clay soil constituents and liquid waste components is meant to highlight some of the problems and issues involved in consideration of contaminant transport in clay soils. The attenuating characteristics of clays, which can be categorized as the carrying capacity of the soil, describes the capability of the soil material in buffering intrusive contaminants. The mechanisms involved depend not only on the type of clays, but also on the nature of the contaminant. The various components, both in the soil and in the overall contaminating leachate, provide for a complex set of actions and interactions. While no complete description or knowledge of the detailed kinds of mechanisms involved in the interactive process with industrial waste leachates exists to date, the basic issues involved require a proper study of all the individual and collective interactions which comprise the high diversity of participating constituents present in the overall system. Because the subject material is extensive and comprehensive, not all the items of concern can be covered. Consideration of some of the fundamental issues has shown that description of specific diffusivities for individual components in the leachate is needed, in terms of time and spatial variability, to describe the contaminant migration rate and extent. In addition,

the buffering capacity of the clay soils needs to be considered in relation to the specific leachate components, and aspects of reaction kinetics evaluated, in order to obtain the necessary appreciation of the carrying capacity of the soil material. (See also W89-01661) (Author's abstract)
W89-01663

NATURAL-GRADIENT EXPERIMENT ON ORGANIC SOLUTE TRANSPORT IN A SAND AQUIFER: SYNOPSIS OF RESULTS,
Stanford Univ., CA. Dept. of Civil Engineering.
D. M. Mackay, and P. V. Roberts.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 26-30, 3 fig, 2 tab, 10 ref. U.S. Assistance Agreement CR-808851.

Descriptors: *Solute transport, *Organic compounds, *Chlorinated hydrocarbons, *Brominated hydrocarbons, *Groundwater pollution, *Path of pollutants, Inorganic tracers, Bromoform, Carbon tetrachloride, Contamination, Sand aquifers, Tetrachloroethylene, Dichlorobenzene, Hexachloroethane, Vertical distribution, Field tests, Computer models, Hazardous materials, Plumes.

A large-scale field experiment was conducted on the natural-gradient transport of 2 inorganic tracers and 5 halogenated organic solutes in the saturated zone of a sandy aquifer. The solute plumes were monitored for 2-3 years using a detailed 3-dimensional sampling network. For each solute plume, quantitative estimates were made of the total solute mass and plume velocity over time. Total mass was conserved for the inorganic tracers and 2 of the organic solutes - carbon tetrachloride and tetrachloroethylene. Total mass declined for bromoform, 1,2-dichlorobenzene and hexachloroethane. The retardation of the organics varied in approximately the same order as their octanol-water partition coefficients, but the retardation factors of the organics appeared to increase with time. Laboratory studies of the aquifer solids have shown that sorption approaches equilibrium slowly and exceeds predictions of the organic carbon partitioning model; in addition, there is significant vertical variability of sorption capacity in the aquifer. Laboratory studies and computer simulations suggest that diffusion limitations of sorption result in the observed increases in retardation of the migrating organic solutes. (See also W89-01661) (Author's abstract)
W89-01664

MIGRATION OF ORGANIC FLUIDS IMMISCIBLE WITH WATER IN THE UNSATURATED AND SATURATED ZONES,
Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
F. Schwille.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 31-35, 4 fig, 2 ref.

Descriptors: *Groundwater pollution, *Organic compounds, *Saturated flow, *Unsaturated flow, *Path of pollutants, Porous media, Fissured media, Contamination, Hazardous materials.

Based on physical models, the migration of organic fluids immiscible with water was investigated. Such tests appear to be indispensible if the flow behavior of these fluids is to be properly understood. Since some of the tests were documented with a time-lapse camera, it was possible to demonstrate the migration process as a film. A migration scheme was introduced for fluids immiscible with water. The report deals briefly with the fluid-mechanical principle of the migration of fluids immiscible with water. The evaluation of the migration behavior (mobility) of these fluids with regard to physical parameters alone does not appear to be reasonable. These parameters should rather be related to the physical characteristics of the porous and fissured media and the fluids (water and oil) contained in the media. (See also W89-01661) (Author's abstract)
W89-01665

GLOUCESTER PROJECT: A STUDY IN ORGANIC CONTAMINANT HYDROGEOLOGY,
Department of the Environment, Ottawa (Ontario). River Road Environmental Technology Center.
R. E. Jackson, J. M. Bahr, D. W. Belanger, and S. Walbridge.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 37-48, 12 fig, 6 tab, 21 ref.

Descriptors: *Groundwater pollution, *Landfills, *Water pollution treatment, *Organic solvents, *Decontamination, *Pump wells, *Path of pollutants, Groundwater velocity, Public health, Hazardous materials, Contamination, Organic compounds, Gloucester Landfill, Aquifers, Ontario, Canada.

The Gloucester Project developed out of research by Environment Canada into the migration of toxic contaminants in an outwash aquifer beneath the Gloucester Landfill near Ottawa. A variety of geophysical, hydrologic and chemical methods were tested at the site to aid in its assessment and remediation. Detailed electromagnetic surveys, ground water velocity measurements and organic chemical sampling were undertaken to assess the migration of the organic solvents. Risk assessment modeling has indicated that there is an unacceptable health hazard from contaminated ground water that is migrating off-site. Consequently, a purge-well evaluation test was undertaken to determine the efficacy of pumping the organic contaminants from the outwash aquifer. The results of this test indicate that the lack of attainment of local chemical equilibrium during the purging operations caused inefficiencies in decontaminating the aquifer. Optimization codes were used to design a purge-well network for the contaminated aquifer. (See also W89-01661) (Author's abstract)
W89-01666

GROUND WATER CONTAMINATION BY ORGANIC CHEMICALS: UNCERTAINTIES IN ASSESSING IMPACT,
California Univ., Los Angeles. School of Public Health.
D. M. Mackay, and T. M. Vogel.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 50-59, 1 fig, 3 tab, 48 ref. EPA Intergovernmental Personnel Act Agreement HQ-052-84-85N.

Descriptors: *Groundwater pollution, *Aquifers, *Water pollution effects, *Organic compounds, *Fate of Pollutants, *Path of pollutants, Hazardous materials, Sorption, Transformation, Contamination, Retardation, Microbial degradation, Santa Clara Valley, California.

Assessment of exposure and risks from chemical contamination of ground water requires the prediction of the probable fate and transport of contaminants over time in the various hydrogeologic zones of concern. For common hydrophobic organic contaminants, such reassessments require quantitative understanding of the sorption of the chemicals into the aquifer solids and the rates and products of possible chemical and biological transformations. In most cases, the field data available from the area under investigation will be insufficient to derive such estimates. With California's Santa Clara Valley as an example, alternative methods for estimation of sorption and transformation are reviewed and the factors that lead to uncertainty in the estimates are discussed. A simple method allows derivation of first-approximation estimates of retardation of a variety of contaminants if reliable field data are available for a few. Although the rates and products of transformations are usually very uncertain, a simple protocol can, in some cases, be used to select conservative assumptions for first-approximation exposure and risk assessment. (See also W89-01661) (Author's abstract)
W89-01667

HOW TO ASSESS THE HAZARDOUS GROUND WATER CONTAMINATION POTENTIAL OF UNCONTROLLED WASTE SITES,
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
G. Milde, H. Kerndorff, V. Brill, and P. Friesel.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 63-68, 16 fig.

Descriptors: *Groundwater pollution, *Waste dumps, *Inorganic compounds, *Organic compounds, *Heavy metals, *Path of pollutants, *Hazardous materials, Contamination, Waste disposal,Boron, Aquifers, Sulfate, Organic halogens, Gas chromatography, West Germany.

The object of this paper was to develop a hierarchic screening procedure for assessing the hazardous ground water contamination potential of uncontrolled waste deposits. The screening procedure should start with inexpensive initial measures, and in the case of confirmed suspicions a sequence of more expensive investigations is to follow. An area with 5 uncontrolled waste deposits of known topographic position, situated in Pleistocene outwash aquifers and normally land-filled down to the ground water table, typical for situations in unconsolidated aquifers, was investigated. A successful investigation procedure was developed consisting of 3 parallel analytical suites consisting of the analysis of inorganic, organic and target constituents. The result showed that in the inorganic suite boron and sulfate (also total organic carbon), and in the organic AOX (adsorbable organic halogens) and GC-fingerprints from different extracts, established in the downstream ground water of the waste sites, prove the hydrochemical connection between the waste and the contamination of the ground water. Further analytical steps identify the contamination more precisely. In the study area the contamination potential of 5 known sites and of 10 previously unknown sites was assessed. In other areas the developed assessment procedure could be employed successfully. (See also W89-01661) (Author's abstract)
W89-01668

DISPOSAL SITE MONITORING DATA: OBSERVATIONS AND STRATEGY IMPLICATIONS,
Lockheed Electronics Co., Inc., Las Vegas, NV.
R. H. Plumb.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 69-77, 4 fig, 5 tab, 9 ref. EPA Contract 68-03-3050 and Contract 68-03-3245.

Descriptors: *Groundwater pollution, *Contamination, *Waste dumps, *Organic compounds, *Path of pollutants, Volatile acids, Pesticides, Waste disposal,Monitoring, Wells, Hazardous materials.

Monitoring data from 358 hazardous waste disposal sites were tabulated to assess the extent of ground water contamination. The tabulated information has identified 720 substances, including 558 organic compounds, that have been reported in the ground water at one or more sites. The observed concentration variability of more than 100 substances, including 31 organic priority pollutants, spans 5 orders of magnitude or more. Although the frequency of detection and concentration range of individual compounds were extremely variable, it was observed that volatile compounds have been reported more frequently (11.7%) than acid extractable compounds (2.5%), pesticides (1.1%) and base/neutral compounds (1.0%). The compiled information has resulted in the identification of several factors that should be considered when a site monitoring strategy is being implemented. First, it is suggested that the observed pattern between volatile organics and other priority pollutants may be useful as an analytical screening technique to determine the need for more extensive organic characterization of ground water samples. Second, consideration should be given to the use of more extensive monitoring well networks to more adequately characterize the spatial and temporal variability that has been observed in the composite data base. Third, a substantial number of substances have been detected at a higher frequency (40) and/or a higher concentration (36) at designated up-

graded wells. This suggests that the present hydrogeologic information at many sites is insufficient and/or that the direction of chemical migration may be influenced by factors other than ground water flow. (See also W89-01661) (Author's abstract)
W89-01669

POTENTIAL RISKS TO A SOLE-SOURCE AQUIFER RECHARGE AREA FROM WASTE DISPOSAL ACTIVITIES: A CASE STUDY,
Geological Survey, Baton Rouge, LA.
B. C. Hanson, and D. P. Boniol.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 78-86, 7 fig, 23 ref.

Descriptors: *Groundwater pollution, *Waste disposal, *Aquifers, *Water pollution sources, Baton Rouge Aquifer, Louisiana, *Sole-source aquifers, *Path of pollutants, Hazardous materials, Solid wastes, Radioactive wastes, Contamination.

The Baton Rouge aquifer system, the only source of fresh ground water for the western part of southeast Louisiana, has been proposed for designation as a sole-source aquifer. Sources of potential contamination to the recharge zone include (1) solid and hazardous waste disposal sites, (2) oil and gas operations, (3) facilities with National Pollution Discharge Elimination System (NPDES) permits, and (4) sites used for nuclear waste storage or nuclear testing. Vulnerability is defined by using qualitative levels of potential risk. The highest level of risk corresponds to virtually all of the Citronelle outcrop area and parts of the Pascagoula-Hattiesburg and Catahoula outcrops. The lowest levels are generally restricted to Quaternary sediments in the southern part of southeast Louisiana. Best management practices for locating surface waste disposal facilities suggest the avoidance of areas with highly permeable soils, wetlands, barren lands, and areas with high water tables. Extreme caution should be exercised in areas characterized by mixed and moderate recharge potentials. Sites near fault zones and shallow salt domes should be scrutinized. Facilities requesting NPDES permits should be evaluated for affect on local ground water quality over time and distance before a permit is issued; curtailment or suspension of discharges may be required during periods of high base flow or during drought conditions. Surface containment pits and salt water injection wells associated with oil and gas activities require stringent construction and maintenance regulations and frequent inspections. (See also W89-01661) (Author's abstract)
W89-01670

CASE STUDY OF THE EFFECTS OF BRINE ON A COMPACTED CLAY TILL LINER,
Golder Associates, Vancouver (British Columbia).
For primary bibliographic entry see Field 8D.
W89-01671

NATURAL-GRADIENT TRACER STUDY OF DISSOLVED BENZENE, TOLUENE AND XYLENES IN GROUND WATER,
Waterloo Univ. (Ontario).
G. C. Patrick, and J. F. Barker.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 141-147, 3 fig, 1 tab, 20 ref.

Descriptors: *Groundwater pollution, *Sand aquifers, *Tracers, *Organic compounds, *Hydrocarbons, *Path of pollutants, Benzene, Xylene, Toluene, Plumes, Hazardous materials, Piezometers, Biotransformation, Hydraulic conductivity, Chloride, Contamination, Aquifers, Environmental tracers.

A solution containing a known mass of dissolved mono-aromatic hydrocarbons (benzene, toluene and xylenes) and chloride was injected as a slug into an unconfined shallow glaciofluvial sand aquifer. Transport of the constituents has been monitored using a dense array of multilevel sampling piezometers, and a series of 5 three-dimensional 'snapshots' of the plumes have been obtained. Vertically averaged concentrations of the chemical constituents have been used to define the horizontal aspects of the plumes and calculations of the centers of mass for each constituent have been performed. Results indicate that the hydrocarbons are all retarded relative to the chloride tracer, and the substantial mass losses of all hydrocarbon constituents have occurred. The losses, which are >90% for all but benzene, have occurred under aerobic conditions within the aquifer and can be attributed to biotransformations. The degree of retardation is similar to that which can be predicted using octanol-water partition coefficient formulations with benzene the least and xylenes the most retarded. The constituents are relatively mobile, however, in the low organic carbon content aquifer. Retardation factors range from only 1.1 for benzene to approximately 1.4 for xylenes. Vertically, the plumes have assumed a distribution that reflects the heterogeneities of the aquifer material. The vertical scale of heterogeneity is of the order of 0.01 m, and hydraulic conductivity contrasts of up to an order of magnitude exist among layers. Retardation has occurred along individual layers with result that concentration-depth profiles at individual locations appear erratic. These profiles illustrate the potential difficulties in monitoring contaminant migration in heterogeneous systems. (See also W89-01661) (Author's abstract)
W89-01676

GEOPHYSICAL SURVEY TO INVESTIGATE CONTAMINANT MIGRATION FROM A WASTE SITE,
Woodward-Clyde Consultants, Baton Rouge, LA.
A. D. Primeaux.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 151-155, 4 fig, 2 tab, 7 ref.

Descriptors: *Groundwater pollution, *Contamination, *Waste dumps, *Path of pollutants, *Conductivity, *Geophysical surveys, Hazardous materials, Borings, Wells.

The purpose of this study was to ascertain if any hazardous pollutants had migrated underground from the closed waste cells and to install monitor wells for long-term monitoring of ground water. A surface geophysical survey was conducted prior to the drilling operations. The survey was conducted utilizing the non-contact terrain conductivity method. The terrain conductivity method was used in an attempt to determine differences in the conductive nature of the subsurface materials as well as to help locate the actual waste areas so that drilling through the waste would be avoided. Based on the results of the terrain conductivity survey, locations for the exploratory borings and monitor well locations were finalized. Upon close examination of the data collected in these borings, it can be seen that borings were indeed drilled within contaminated zones and that borings were drilled in uncontaminated areas. A conclusion made from this investigation is that the surface geophysical survey minimized the number of wells required and also aided in locating borings to properly monitor contaminated ground water migration in a most cost-effective manner. (See also W89-01661) (Author's abstract)
W89-01677

IMPEDANCE COMPUTED TOMOGRAPHY ALGORITHM AND SYSTEM FOR GROUND WATER AND HAZARDOUS WASTE IMAGING,
Manitoba Univ., Winnipeg. Dept. of Electrical Engineering.
For primary bibliographic entry see Field 2F.
W89-01678

TOMOGRAPHIC IMAGING OF GROUND WATER POLLUTION PLUMES,
Faraci (E.J.) and Associates, Winnipeg (Manitoba).
For primary bibliographic entry see Field 2F.
W89-01679

GROUND WATER CONTAMINATION ASSOCIATED WITH WASTE DISPOSAL INTO A WATER-FILLED OPEN-PIT COAL MINE,
Alberta Environment, Edmonton.
W. J. Ceroici.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 196-201, 8 fig, 1 tab, 4 ref.

Descriptors: *Groundwater pollution, *Contamination, *Waste disposal, *Water quality, *Path of pollutants, Coal mines, Industrial wastes, Municipal wastes, Lakes, Monitoring, Sampling, Calcium, Magnesium, Sodium, Chloride, Sulfates, Waste management, Dissolved solids, Organic compounds, Leachates, Plumes, Wells, Hydraulic gradient, Tritium, Electromagnetic survey, Alberta, Canada.

A portion of an abandoned open-pit coal mine near Cardiff, Alberta, Canada, was used as a disposal site for municipal and possibly industrial wastes from approximately 1960-1975. Refuse was dumped into standing water reportedly 6-15m (20-50 ft) deep. In 1979 a decision was made to reclaim the disposal site, as well as the rest of the mine area for use as a recreational park. Concern that leachate-contaminated ground water might pollute water in an adjacent lake prompted a ground water investigation, which consisted of an electromagnetic survey, installation of a ground water monitoring system and ground water sampling. Water level data indicate that the water table is mounded in the refuse and that the lake is located downgradient from the reclaimed disposal area. A steep hydraulic gradient is evident in the low permeability surficial material separating the reclaimed disposal site from the lake. Shallow ground water in the area varies from the calcium/magnesium-sulfate to the sodium-sulfate type with a total dissolved solids concentration generally exceeding 3,000 mg/L. Leachate-contaminated ground water is characterized by a high organic load, a low sulfate concentration and a high chloride concentration. Information about the spatial variability of the chloride concentration was used to assess the extent of ground water contamination. A chloride plume, approximately 150m (500 ft) wide, extends vertically to the bedrock surface. Elevated chloride concentrations in lake water and in ground water from downgradient wells indicate that contaminated ground water has migrated at least 400m (1300 ft) laterally downgradient. (See also W89-01661) (Author's abstract)
W89-01683

CYANIDE CONTAMINATION NEAR ELK CITY, IDAHO: THE REGULATORY IMPLICATIONS,
Idaho State Dept. of Health and Welfare, Boise.
A. E. Murrey, and J. R. Moeller.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 209-214, 2 fig, 8 ref.

Descriptors: *Groundwater pollution, *Water pollution sources, *Legal aspects,*Cyanide, *Leaching, *Mine wastes, *Potable water, *Path of pollutants, Monitoring wells, Waste management, Hazardous materials, Regulations, Idaho.

A proposed cyanide heap leach mining operation in central Idaho caused considerable controversy among residents and regulatory agencies in 1983. The facility is located several hundred feet upstream of Elk City's drinking water intake. Concern focused on safety of the process and the potential for surface and ground water contamination. Construction and operation began in late 1983. In March 1984 cyanide contamination was detected in the monitoring wells and in Big Elk Creek, which serves as the potable water supply for Elk City. A notice of violation of state regulations was issued to the company by the Idaho Department of Health and Welfare, Bureau of Water Quality. The company quickly initiated ground and surface water monitoring and relocated the community drinking water intake upstream of the mining operation. The Bureau requested the EPA to issue an administrative order, which required the company to halt the release of hazardous substances, to remove hazardous wastes and to eliminate the threat of further release of hazardous substances into the water supply and

ground water. The company has extracted minimal precious metals and it has incurred cost of the order of hundreds of thousands of dollars as a result of cleanup operations which began in June 1984. As a result of this incident, regulatory officials in Idaho have obtained better understanding of factors relating to siting, design, construction and monitoring such facilities. (See also W89-01661) (Author's abstract)
W89-01685

INVESTIGATION OF GROUND WATER QUALITY AT A DECOMMISSIONED SOUR GAS PLANT IN ALBERTA,
Monenco Consultants Ltd., Calgary (Alberta).
T. Kewen, G. E. Grisak, and L. T. L. Callow.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 219-224, 8 fig, 10 ref.

Descriptors: *Groundwater pollution, *Contamination, *Water quality, *Natural gas wastes, *Industrial plants, *Path of pollutants, Sulfates, Organic materials, Isotope studies, Silt, Groundwater movement, Geophysics, Hydraulic models, Sour gas plant, Alberta, Canada.

The Gulf Pincher Creek gas plant in southwestern Alberta is the first major sour gas facility to be decommissioned in Alberta. The site is situated on 30 to 45m of silty clay till overlying preglacial gravels and fine grained bedrock. Ground water quality studies indicate that only shallow ground waters in the area have been affected by the 28-year operation of the plant. Sulfates and organic compounds from gas processing are present in ground waters in central portions of the plant site beneath the process area and surface water drainage ways. Shallow ground water movement through the till in these areas is estimated to be less than 1 meter per year. Ground waters in these areas do not pose an off-site concern. Sulfates are also present within intertill silt deposits which extend beneath a pond which previously collected runoff from the sulfur storage area. These silts continue off-site and the extent of sulfate migration within these silts was determined by using conventional field methods, as well as surface geophysics and sulfur isotope sampling. The geophysics was more useful in defining the areal extent of the silts rather than the sulfates. The isotopes showed a very distinct separation between sulfates derived from plant site sulfur and natural soil sulfur. The effects of future migration of sulfates was investigated using a three-dimensional transport model. The results suggest that future off-site effects of the sulfates on ground water and surface water use will be limited. (See also W89-01661) (Author's abstract)
W89-01686

EFFECTS OF THE 1982 AMOCO-DOME BRAZEAU RIVER GAS WELL BLOWOUT ON THE SUBSURFACE ENVIRONMENT,
Campbell Geoscience Ltd., Calgary (Alberta).
K. W. Campbell.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 225-232, 9 fig, 1 tab, 6 ref.

Descriptors: *Groundwater pollution, *Water quality, *Contamination, *Oil industry, *Path of pollutants, *Natural gas, Gas wells, Hydrocarbons, Piezometers, Surface runoff, Subsurface infiltration, Subsurface condensate, Alberta, Canada.

In October 1982 a gas well drilled by Amoco Petroleum (Canada) near Lodgepole, Alberta, experienced a 67-day period of uncontrolled flow of reservoir fluids, depositing hydrocarbon condensate over an area of approximately 10 sq km (4 sq miles) adjacent to Zeta Creek near its confluence with the Pembina River. After the well had been capped, Amoco initiated a program to monitor, assess damages and implement remedial and reclamation measures to minimize the effect of the blowout on the environment. A drilling program was undertaken to characterize the surficial geology and the local hydrogeological regime. A network of approximately 54 piezometers was installed over the site and fluid levels monitored to detect the presence and movement of free condensate in the shallow subsurface. The field program revealed that large volumes of condensate had infiltrated into the subsurface and were mobile along several stratigraphic horizons. A series of strategically located ditches, trenches, keyed-in-dikes and pits were constructed as an integral part of controlling surface runoff and the subsurface movement of condensate toward Zeta Creek and the Pembina River. These excavations permitted direct observation of subsurface condensate movement in several stratigraphic horizons and permitted collection of large volumes of condensate. The measures implemented proved cost-effective in confining and collecting free condensate on the lease site. The project demonstrates the importance of understanding the geological conditions on a spill site and the cost-effectiveness of relatively simple cleanup and containment procedures. (See also W89-01661) (Author's abstract)
W89-01687

RISK ASSESSMENT OF DEEP WELL INJECTION SYSTEMS,
Underground Resource Management, Inc., Austin, TX.
For primary bibliographic entry see Field 5E.
W89-01688

EVALUATION OF HAZARDOUS LIQUID WASTE DISPOSAL,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 5E.
W89-01690

CHARACTERIZATION OF BASELINE PRECIPITATION AND STREAM CHEMISTRY AND NUTRIENT BUDGETS FOR CONTROL WATERSHEDS,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
For primary bibliographic entry see Field 2K.
W89-01695

ECOLOGICAL EFFECTS OF IN SITU SEDIMENT CONTAMINANTS.
For primary bibliographic entry see Field 5C.
W89-01714

PHYSICS OF SEDIMENT TRANSPORT, RESUSPENSION, AND DEPOSITION,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2J.
W89-01715

SEDIMENTS AS A SOURCE FOR CONTAMINANTS,
Waterloopkundig Lab. te Delft (Netherlands).
W. Salomons, N. M. de Rooij, H. Kerdijk, and J. Bril.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 13-30, 14 fig, 1 tab, 49 ref.

Descriptors: *Sediments, *Water pollution sources, *Path of pollutants, Copper, Zinc, Cadmium, Trace metals, Sulfides, Chromium, Arsenic, Adsorption, Sediment contamination, Fate of pollutants.

The processes affecting trace metals in deposited sediments are reviewed. The sediment-water system can be divided in three parts: the oxic layer, the anoxic layer and the oxic-anoxic interface. Available data show that trace metals like Cu, Zn and Cd occur as sulfides in marine and estuarine anoxic sediments. Calculations show that organic complexation in unlikely and the dominant species are sulfide and bisulfide complexes. Chromium and arsenic are probably present as adsorbed species on the sediments; their concentrations in the pore waters, therefore depend on the concentrations in the sediments. The oxic-anoxic interface plays the major role in the potential flux of trace metals from the sediments, however this interface is not well studied at present. Changes from an anoxic to an oxic environment as occurs during dredging and land disposal of contaminated sediments may cause a remobilization of some trace metals. (See also W89-01714) (Author's abstract)
W89-01716

BIOLOGICAL PROCESSES INVOLVED IN THE CYCLING OF ELEMENTS BETWEEN SOIL OR SEDIMENTS AND THE AQUEOUS ENVIRONMENT,
Minnesota Univ., Navarre. Gray Freshwater Biological Inst.
J. M. Wood.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 31-42, 6 fig, 1 tab, 23 ref. National Institutes of Health Grant AM 18101.

Descriptors: *Path of pollutants, *Biochemistry, *Sediment contamination, *Toxicity, Biological studies, Chemical reactions, Sodium, Potassium, Cycling nutrients, Calcium, Magnesium, Iron, Manganese, Nickel, Copper, Zinc.

The biochemical basis for resistance to toxicity is complicated by the great variety of reactions at the molecular and cellular levels even in closely related organisms and tissues. Several strategies for resistance to intoxication have been identified. Metal ion interactions in biology can be divided into three classes representing fast, intermediate and slow exchange with biological ligands. Examples of those elements in fast exchange include the alkali metals Na(+) and K(+), the alkali earth metals Ca(2+) and Mg(2+), and, H(+). Those which can sometimes be an intermediary exchange are Fe(2+), Zn(2+), Ni(2+), Cu(2+). The cycling of one essential element (nickel) and one non-essential element (mercury) are reviewed with special emphasis on their mobilities in the event of in situ sediment contamination. (See also W89-01714) (Author's abstract)
W89-01717

PARTITIONING OF TRACE METALS IN SEDIMENTS: RELATIONSHIPS WITH BIOAVAILABILITY,
Quebec Univ., Sainte-Foy.
A. Tessier, and P. G. C. Campbell.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 43-52, 1 fig, 3 tab, 49 ref.

Descriptors: *Trace metals, *Bioavailability, *Fate of pollutants, *Path of pollutants, *Partitioning, Model studies, Sediment contamination, Metals, Pore water, Chemical properties, Physical properties.

As a result of complex physical, chemical and biological processes, a major fraction of the trace metals introduced into the aquatic environment is found associated with the bottom sediments, distributed among a variety of physico-chemical forms. Since these different metal forms generally exhibit different chemical reactivities, the measurement of the total concentration of a particular metal provides little indication of potential interactions with the abiotic or biotic components present in the environment. In principle, the partitioning of sediment-bound metals could be determined both by thermodynamic calculations (provided equilibrium conditions prevail) and by experimental techniques. The modelling of sediment-bound metals is far less advanced than is that of dissolved species, primarily because the thermodynamic data needed for handling sediment-interstitial water systems are not yet available. The partitioning of a metal among various fractions obtained by experimental techniques (e.g., sequential extraction procedures) is necessarily operationally defined. These methods have, however, provided significant insight into the physico-chemical factors influencing the bioa-

vailability of particulate trace metals; some of these factors are discussed. (See also W89-01714) (Author's abstract)
W89-01718

INTERACTIONS BETWEEN SEDIMENT CONTAMINANTS AND BENTHIC ORGANISMS,
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Regional Office.
T. B. Reynoldson.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 53-66, 2 fig, 5 tab, 90 ref.

Descriptors: *Sediment contamination, *Benthic fauna, *Path of pollutants, *Toxicity, *Water pollution effects, Invertebrates, Midges, Oligochaetes, Fish, Shellfish, Ecological effects, Bioaccumulation.

An overview of interactions between contaminated sediments and benthic invertebrates in marine and freshwater systems using selected examples from available literature, is presented. Impacts on the benthic community (e.g., acute toxicity, morphological and genetic changes in the Chironomidae and Oligochaeta, and induction of carcinogenesis) and changes in community structure are discussed. The benthos, as a result of direct association with sediment, can act as accumulators and conductors of contaminant by physical, chemical, and biological processes within the sediment they inhabit. The significant of these processes will have to be considered in any attempt to manage contaminated sediment material; whether it be the benthic populations themselves because of their economic importance (e.g., shellfish industry), their activity in biomagnification or in the transfer of contaminants to economically important fish stocks. (See also W89-01714) (Lantz-PTT)
W89-01719

SEDIMENT-ASSOCIATED CONTAMINANTS AND LIVER DISEASES IN BOTTOM-DWELLING FISH,
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
For primary bibliographic entry see Field 5C.
W89-01720

HUMAN POPULATION: AN ULTIMATE RECEPTOR FOR AQUATIC CONTAMINANTS,
Michigan Dept. of Public Health, Lansing. Center for Environmental Health Sciences.
H. E. B. Humphrey.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 75-80, 2 fig, 4 tab, 18 ref.

Descriptors: *Path of pollutants, *Population exposure, *Public health, *Fish, Lake Michigan, Polychlorinated biphenyls, DDT, DDE, Biochemistry, Toxicity, Food chains.

Human consumption of sport-caught fish represents a significant route of exposure to aquatic chemical contaminants. To investigate this, a cohort of Michigan residents was established and evaluated in 1974 and 1981. PCB, DDT and DDE concentrations dominated the eleven contaminants found in participant blood specimens. Those who regularly ate Lake Michigan fish had serum PCB levels up to 30 times greater than those who did not eat these fish. Serum levels briefly increased following each fish meal, correlated with annual fish consumption and correlated with the number of years fish had been consumed. Some homologs of PCB found at elevated levels in fisheaters have toxic properties. It appears that the human population can be a final receptor for persistent toxic chemical contaminants found in the environment. (See also W89-01714) (Author's abstract)
W89-01721

USE OF BIOASSAY AND ASSOCIATED TESTS IN DREDGED MATERIAL AND DISPOSAL MANAGEMENT,
Corps of Engineers, Vicksburg, MS.
C. R. Lee, R. K. Peddicord, B. L. Folsom, and J. G. Skogerboe.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 81-86, 1 fig, 4 tab, 11 ref.

Descriptors: *Bioassay, *Dredging, *Waste disposal, *Waste management, *Path of pollutants, Plants, Cadmium, Zinc, Copper, Chromium, Lead, Simulated rainfall, Environmental effects.

Plant bioassays and simulated rainfall-surface runoff tests have been developed and are being refined to assist in the evaluation of the environmental impact of dredged material disposal alternatives. Plant bioassay tests have been used to give appropriate information to describe the potential for contaminant mobility from dredged material into plants colonizing wetland and upland disposal environments. Index plants have shown elevated contents of Cd, Zn, Cu, Cr and Pb when grown on contaminated dredged material placed in a terrestrial disposal environment. Simulated rainfall-surface runoff water quality tests are being developed to determine the potential for contaminant mobility resulting from physicochemical changes in dredged material following upland disposal. A management strategy has been developed that incorporates the above test results for a selection of environmentally acceptable dredged material disposal alternatives. (See also W89-01714) (Author's abstract)
W89-01722

ASSESSING THE BIOACCUMULATION OF CONTAMINANTS FROM SEDIMENTS BY FISH AND OTHER AQUATIC ORGANISMS,
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
For primary bibliographic entry see Field 5A.
W89-01724

CASE STUDY: BAY OF POZZUOLI (GULF OF NAPLES, ITALY),
ENEA, La Spezia (Italy). Centro Richerche Energia Ambiente.
V. Damiani, R. Baudo, S. De Rosa, R. De Simone, and O. Ferretti.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 201-211, 7 fig, 5 tab, 9 ref.

Descriptors: *Case studies, *Bay of Pozzuoli, *Pollutant identification, *Italy, *Path of pollutants, *Water pollution sources, Organic matter, Metals, Polychlorinated biphenyls, Aromatic compounds, Hydrocarbons, DDT, Copper, Iron, Mercury, Manganese, Lead, Zinc, Industrial wastewater, Farm wastes, Bioaccumulation.

The Centro Ricerche Energia Ambiente (ENEA) examined the sediments of Pozzuoli Bay for contamination of metals, organic matter, PCBs, PAHs and DDT. The physical characteristics of surficial sediments reflected volcanic and industrial activity in the region. Elevated concentrations of Cu, Fe, Hg, Mn, Pb and Zn were present in the sediments of littoral areas near industrial centers. Carbon/nitrogen ratios (> 20) of sediments indicated that organic matter was of an allochthonous origin. Industrial and agricultural activity in the area was reflected through elevated concentrations of PCBs, PAHs and DDT. Although the region has maintained an important fishing industry, there was no evidence of change in the commercial fish catch at the Port of Pozzouli from 1979 to 1983 which could be correlated with contaminated sediments. (See also W89-01714) (Author's abstract)
W89-01732

CONSEQUENCES OF ENVIRONMENTAL CONTAMINATION BY LEAD MINING IN WALES,
Bradford Univ. (England). School of Environmental Science.
B. E. Davies.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 213-220, 3 fig, 37 ref.

Descriptors: *Environmental effects, *Lead, *Mine wastes, *Path of pollutants, *Bioaccumulation, Water pollution effects, Copper, Zinc, Sediment contamination, Soil contamination, Rivers, Wales.

Lead mining in Wales originated before the Roman Occupation. The main active period was from 1750-1900 when zinc and copper were also mined and during this period only simple and inefficient ore processing methods were available. Consequently large amounts of copper, lead and zinc compounds were lost to the environment and have since become incorporated in sediments and soils. Locally, pollution may still occur from drainage from abandoned mines and by mobilization of mine tailings. The present state of Welsh rivers ane the distribution of contaminants in sediments and soils are reviewed. The uptake of heavy metals by plants and the consequences for human health are also discussed. (See also W89-01714) (Author's abstract)
W89-01733

SEDIMENT-ASSOCIATED CONTAMINANTS: AN OVERVIEW OF SCIENTIFIC BASES FOR DEVELOPING REMEDIAL OPTIONS,
Technische Univ. Hamburg-Harburg (Germany, F.R.).
U. Forstner.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 221-246, 7 fig, 3 tab, 248 ref.

Descriptors: *Sediment contamination, *Literature review, *Path of pollutants, *Water pollution effects, Water pollution sources, Bioaccumulation, Environmental effects, Biological studies, Chemical studies, Organic compounds.

This review article covers three major aspects of scientific research on sediment-associated contaminants during the last 20 years: (1) identification and monitoring of sources and distribution (sampling; Sample preparation; analyses, mainly of non-residual fractions; estimation of pollution potential); (2) study of processes and mechanisms of pollutant transfer (interactions between dissolved and particulate element species; particle environments; transport and diagenesis; colloids; surface microlayers; particle related processes; bioturbation; dredging operations; remobilization of toxic elements; bioaccumulation of organic chemicals; solid/dissolved distribution of contaminants); and (3) assessment of the environmental impact of particle-bound pollutions (chemical extraction sequence; sediment bioassay; combined chemical/biological test procedure). Instead, empirical tests developed from multi-disciplinary research on biological, chemical and physical factors are applied for assessing the reactivity, mobility and bioavailability of sediment-bound pollutions and for estimating the validity of remedial measures. (See also W89-01714) (Author's abstract)
W89-01734

UNDERGROUND STORAGE SYSTEMS: LEAK DETECTION AND MONITORING,
Groundwater Technology, Inc., Annapolis Junction, MD.
For primary bibliographic entry see Field 5A.
W89-01765

COMPARISON OF FIELD AND LABORATORY BIOACCUMULATION OF ORGANIC AND INORGANIC CONTAMINANTS FROM BLACK ROCK HARBOR DREDGED MATERIAL,
Environmental Research Lab., Narragansett, RI.
For primary bibliographic entry see Field 5C.

W89-01773

PERSISTENCE OF BIOLOGICALLY ACTIVE COMPOUNDS IN SOIL,
Wyoming Univ., Laramie. Dept. of Plant Science.
S. E. Williams.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-010250. Price codes: A06 in paper copy, A01 in microfiche. DOE Report No. DOE/ER/60072--T1, February 1987. 106p, 32 fig, 5 tab, 23 ref. DOE Contract ER60072.

Descriptors: *Fate of pollutants, *Soil contamination, *Water pollution effects, *Oil shale wastes, *Industrial wastewater, Fuel, Organic compounds, Inorganic compounds, Oil shale, Biological studies, Plant growth, Mycorrhizae, Waste disposal, Land treatment, Leachates, Nitrogen bacteria.

Process water produced during fossil fuel extraction generally contain high concentrations of dissolved organic and inorganic constituents. Past research efforts have been directed toward evaluation of microbial interactions with an aqueous effluent obtained from the Laramie Energy Technology Center's (LETC) site 9 in situ oil shale processing experiment located near Rock Spring, Wyoming. Microorganisms have been shown to survive and grow in this water (Omega-9 water). These organisms have an impact on stability of stored Omega-9 water samples and may be highly important in water treatment prior to disposal. However, despite the importance of process water treatment, a more immediate concern is the influence of untreated or partially treated waters on the soil and on the biotic communities in direct contact with soil: microorganisms and plants. A fundamental question concerning process water is the influence they might have on agricultural systems when these waters come in contact with soils. Contact of these waters with soil will certainly modify physical, chemical, as well as biological properties of soils. One of the most fundamental biological properties which influence plant growth are symbiotic microbial systems in the soil. These systems are of basically two categories: (1) Nitrogen fixing symbioses between prokaryotic organisms and the plant, and (2) vesicular arbuscular (VA) mycorrhizal associations between certain fungi and the plant. Nitrogen fixation and VA mycorrhizal associations have been shown to be negatively influenced by spent oil shale. VA mycorrhizal associations have considerable beneficial influence on growth of plants which they infect. These primarily act to increase plant uptake of phosphates and water, as well as other essential nutrients, and tend to be absent in severely disturbed soils. It is well established that VA mycorrhizal associations are normally associated with native plant communities in arid regions. The objectives of this research are: (1) treat representative soils with an oil shale leachate water, (2) determine the influence of the leachate on the soil's ability to support plant growth, and (3) ascertain its influence on symbiotic N2-fixing bacteria and mycorrhizal fungi. (Lantz-PTT)
W89-01778

ENVIRONMENTAL MONITORING AT MOUND: 1986 REPORT,
Monsanto Research Corp., Miamisburg, OH. Mound.
D. G. Carfagno, and B. M. Farmer.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-010563. Price codes: A03 in paper copy, A01 in microfiche. Monsanto Report No. MLM-3427, May 11, 1987. 46 p, 5 fig, 30 tab, 17 ref, append. DOE Contract DE-AC04-76-DP00053.

Descriptors: *Monitoring, *Mound, *Florida, *Great Miami River, *Tritium, *Nuclear wastes, Plutonium, Industrial wastes, Tritium oxide, Standards, Air pollution, Water pollution, Drinking water, Food chain.

Mound is a government-owned facility operated by Monsanto Research Corporation for the U.S. Department of Energy (DOE). In 1949, Mound began operations for the production of nuclear weapon components. The local environment around Mound was monitored primarily for tritium (3-H) and plutonium-238 (238-Pu). The results are reported for 1986. The average concentrations of 238-Pu and 3-H were within the DOE interim air and water Derived Concentration Guides (DCG) for these radionuclides. The average incremental concentrations of 238-Pu and 3-H-oxide in air measured at all offsite locations during 1986 were 7.5 times 10 to the -18th microCuries/mL and 10.4 times 10 to the -12th microCuries/mL, respectively. These correspond to 0.03% and 0.01% of the DOC Derived Concentration Guides (DCG) for uncontrolled areas. The average incremental concentration of 238-Pu measured at all locations in the Great Miami River during 1986 was 2.1 times 10 to the -12th microCuries/mL which is 0.0005% of the DOE DCG. The average incremental concentration of 3-H measured at all locations in the Great Miami River during 1986 was 0.0000009 microCuries/mL which is 0.005% of the DOE DCG. The average concentrations in local private and municipal drinking water systems were < 25% and 1.5%, respectively, of the U.S. EPA standards. The concentrations found in foodstuffs were extremely low. The dose equivalent estimates for the average air, water, and foodstuff concentrations indicate that the levels are within 1% of the DOE standard of 100 mrem. (Lantz-PTT)
W89-01779

INTERCALIBRATION OF ANALYTICAL METHODS ON MARINE ENVIRONMENTAL SAMPLES. RESULTS OF MEDPOL-II EXERCISE FOR THE INTERCALIBRATION OF CHLORINATED HYDROCARBON MEASUREMENTS ON MUSSEL HOMOGENATE (MA-M-2/OC).
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
For primary bibliographic entry see Field 5A.
W89-01780

COMMUNITY TOXICITY TESTING.
For primary bibliographic entry see Field 5C.
W89-01783

MODELING GROUNDWATER FLOW AND POLLUTION: WITH COMPUTER PROGRAMS FOR SAMPLE CASES,
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-01810

INTERCALIBRATION OF ANALYTICAL ETHODS ON MARINE ENVIRONMENTAL SAMPLES: RESULTS OF MEDPOL II EXERCISE FOR THE INTERCOMPARISON OF TRACE ELEMENT MEASUREMENTS ON MUSSEL TISSUE HOMOGENATE AND MARINE SEDIMENT (MA-M-2/TM AND SD-N-1/2/TM).
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
For primary bibliographic entry see Field 5A.
W89-01813

PROCEEDINGS OF THE FOREST-ATMOSPHERE INTERACTION WORKSHOP.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009894. Price codes: A10 in paper copy, A01 in microfiche. Lake Placid, New York, October 1-4, 1985. DOE Report No. CONF-8510250, May 1987. 249p. Edited by Harry Moses, Volker A. Mohnen, William E. Reifsnyder, and David H. Slade.

Descriptors: *Forest hydrology, *Canopy, *Conferences, *Acid rain, Throughfall, Biomass, Information exchange, Plant pathology, Workshops, Forests, Research priorities.

Many of the potential causes of forest decline are considered in this workshop procedings. In addition, attention is devoted to methods of detecting changes in forest growth such as remote sensing techniques and biochemical indications. The workshop was divided into three main sections: (1) Forest Science and Management; (2) Atmosphere Canopy Exchange; and (3) Biomass Decline. The workshop, aimed to (1) discuss problem areas and identify new issues concerning forest-atmosphere interactions; (2) provide information exchange; and (3) provide recommendations for research. (See W89-01816 thru W89-01818) (Lantz-PTT)
W89-01815

CHEMICAL INTERACTION OF A FOREST CANOPY WITH THE ATMOSPHERE,
Wyoming Univ., Laramie. Dept. of Botany.
W. A. Reiners, G. M. Lovett, and R. K. Olson.
IN: Proceedings of the Forest-Atmosphere Interaction Workshop. Lake Placid, New York, October 1-4, 1985. DOE Report No. CONF-8510250, May 1987. p 111-146, NSF Grant BSR-8316228. 7 fig, 1 tab, 22 ref.

Descriptors: *Path of pollutants, *Forest hydrology, *Canopy, *Acid rain, Air pollution, Sulfates, Heavy metals, Sulfates, Nitrites, Ammonia, Model studies, Water chemistry, Solute transport, Throughfall, Stemflow.

A series of investigations are reviewed that increased chemical interactions between the atmosphere and canopies of subalpine balsam fir forests. These forests are found just below treeline in the Adirondack, Green, and White Mountains of northeastern U.S. Besides being subject to considerable loading of heavy metals, NH4(+), NO3(-), SO4(2-) and H(+) ions through cloud droplet deposition as well as incident precipitation, this forest type is a good model for research because of its simplicity and small stature. Throughfall (TF) and stemflow (SF) solutions are characteristically highly enriched in Ca(+), Mg(+), K(+) and SO4(2-); slightly enriched in H(+), Na(+) and sometimes NO3(-), and depleted in NH4(+) (and sometimes NO3(-)). A detailed experimental analysis of efflux and influx of ions out of and into various canopy components over time revealed quite different behaviors that were specific to components, length of storm, and sometimes rain rates. These results plus show interval analyses of natural storm TF-SF led to generalizations on ion flux in storm events for this canopy, and canopies in general. Specific rates depend on the species composing the forest and the condition of canopy components during the storm. For all canopies, however, the principal variables controlling TF-SF flux rates are: (1) precipitation ion flux rate; (2) canopy water storage pool turnover rate; (3) the concentration gradient between the storage pool and tissue apoplasm; and (4) the effect of the storage pool turnover rate on depletion of ions that efflux, and on in-tissue saturation of ions that influx. (See also W89-01815) (Lantz-PTT)
W89-01816

GAS EXCHANGE BETWEEN FOREST AND ATMOSPHERE,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Lab.
C. E. Murphy.
IN: Proceedings of the Forest-Atmosphere Interaction Workshop. Lake Placid, New York, October 1-4, 1985. DOE Report No. CONF-8510250, May 1987. p 147-181, 6 fig, 48 ref. DOE Contract DE-AC09-76SR00001.

Descriptors: *Forest hydrology, *Gas exchange, *Throughfall, *Forests, Path of pollutants, Remote sensing, Air pollution, Prediction model studies, Plant physiology.

The subject of gas exchange between the atmosphere and forests has been of interest to plant scientists for many years because of the crucial role exchange of water and carbon dioxide plays in the survival, growth and competition between plants. More recently, attention has been directed to gas exchange because of interest in uptake of pollutants by forest vegetation. Forest gas exchange is discussed in terms of the processes which control the rate of exchange with the atmosphere. Examples show how vegetative uptake is controlled in gases with different characteristics. The prediction of uptake for large areas and over long periods of

time is discussed in terms of quantitative models of the gas exchange processes. Remote sensing is suggested as a means of obtaining the parameters needed to make model predictions. (See also W89-01815) (Author's abstract)
W89-01817

FOREST SOILS AND ACID DEPOSITION: AN OVERVIEW AND SYNTHESIS,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
D. Binkley.
IN: Proceedings of the Forest-Atmosphere Interaction Workshop. Lake Placid, New York, October 1-4, 1985. DOE Report No. CONF-8510250, May 1987. p 222-236, 6 fig, 1 tab, 20 ref. NSF Grant BSR-8406987.

Descriptors: *Acid rain, *Forests, *Soil contamination, *Path of pollutants, Acidification, Adsorption, Weathering, Ecosystems, Hydrogen ion concentration, Epidemiology, Policy making, Leaching, Nitrates.

Soil acidification can be driven by both deposition of chemicals from the atmosphere and internal-ecosystem processes. The potential effects of acid deposition can be evaluated in an ecosystem context through the use of H(+) budgets. Soil acidity comprises H(+) free in soil solution, exchangeable pools of H(+) and Al3(+), and titratable pools of H(+) that can be removed only by strong bases. Major processes that add H(+) to ecosystems include: dissociation of carbonic acid (formed by carbon dioxide dissolving in water), production and dissociation of organic acids, uptake of nutrient cations by plants and microbes, production of nitric acid from oxidation of ammonia coupled with nitrate leaching from the soil, and atmospheric deposition. Major H(+) consuming processes include: adsorption on cation exchange sites, protonation of organic acids, release of nutrient cations from organic matter through decomposition or fire, specific adsorption of anions, and weathering of soil minerals. Soils that are most sensitive to acidification are often characterized as young, shallow, coarse-textured, and lacking in carbonates and other readily weatherable minerals. Aquatic ecosystems can be acidified, or subjected to elevated inputs of aluminum, even if atmospheric deposition has not acidified surrounding terrestrial ecosystems. Much research is needed to improve our understanding of H(+) budgets and ecosystem acidification, but obtained only in severely damaged ecosystems. Policy makers need to view the risks from a epidemiological viewpoint rather hope for conclusive scientific experimentation. (See also W89-01815) (Author's abstract)
W89-01818

HANDBOOK OF NONPOINT POLLUTION: SOURCES AND MANAGEMENT,
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
V. Novotny, and G. Chesters.
Van Nostrand Reinhold Environmental Engineering Series. Van Nostrand Reinhold Co., New York. 1981. 555p.

Descriptors: *Water pollution sources, *Land use, *Acid rain, *Nonpoint pollution sources, Water pollution effects, Erosion, Air pollution, Groundwater pollution control, Urban runoff, Water conservation, Model studies, Water pollution control.

Until recently, almost all pollution control efforts focused on reduction of pollution from point sources such as municipal sewage and industrial wastewater. Extensive research has revealed, however, that major problems are caused by nonpoint pollutants - those originating from aerial diffuse sources that are mostly related to man's use of land. Sources and magnitudes of nonpoint pollution, major causative factors, and disturbing activities on land that lead to elevated pollution loadings from diffuse sources are described. Related topics discussed in detail include erosion, hydrologic factors, atmospheric deposition and acid rain, soil degradation and absorption of pollutants, groundwater pollution, urban nonpoint pollution and its mitigation, nonurban pollution and soil conservation practices, modeling techniques, management practices for control of nonpoint pollution, and long-range planning for nonpoint pollution control. (Lantz-PTT)
W89-01822

VADOSE ZONE MODELING OF ORGANIC POLLUTANTS.
Lewis Publishers, Inc., Chelsea, Michigan. 1986. 295p. Edited by Stephen C. Hern and Susan M. Melancon.

Descriptors: *Path of pollutants, *Model studies, *Organic compounds, *Vadose water, *Soil contamination, *Soil water, Solute transport, Groundwater movement, Chemical reactions, Geochemistry.

A variety of stochastic and deterministic soil leaching models have been developed in the past decade, particularly to measure the transport and transformation of organic pollutants moving through the vadose zone. The Frist four chapters of the book provide background information to the general model user. Chapter 1 includes an overview of the basic soil processes represented in vadose zone model, including process definitions and common model assumptions. In particular, SESOIL, PRZM, and PESTAN transformation processes presumed operative in the vadose zone are examined more closely. Chapter 3 introduces a stepwise generic approach for the implementation of a data acquisition strategy which can be used in field model testing. This chapter provides guidelines on criteria to be used in model selection and establishment of validation acceptance criteria, as well as site and compound selection, and implementation of a field sampling program. Chapters 4 and 5 then present two scenarios describing actual field validation attempts using the three models that have been more closely scrutinized. The second section presents papers on chemical processes, parameter estimation, and variability in the vadose zone, thorough discussions of: chemical movement through soil, volatilization from soil, adsorption of organic chemicals onto soil, biotransformation, nonbiological transformation, and spatial variability of soil properties. (See W89-01860 thru W89-01870) (Lantz-PTT)
W89-01859

OVERVIEW OF TERRESTRIAL PROCESSES AND MODELING,
Aqua Terra Consultants, Palo Alto, CA.
A. S. Donigian, and P. S. C. Rao.
IN: Vadose Zone Modeling of Organic Pollutants. Lewis Publishers, Inc., Chelsea, Michigan. 1986. p 3-35, 2 fig, 4 tab, 73 ref.

Descriptors: *Path of pollutants, *Model studies, *Fate of pollutants, *Soil water, Mathematical models, Groundwater movement, Vadose water, Pesticides.

The terrestrial environment which extends from the top of the growing vegetation to the capillary fringe of groundwater is the primary home for most living things on earth. Chemicals are deliberately introduced into this environment to grow and expand the food supply, to protect people and crops from pests and disease, and to dispose of wastes; unintended entry also occurs through transport accidents, inaccurate or inappropriate application procedures, and leaking storage facilities. This chapter presents an overview of the processes influencing the fate and migration of chemicals in the terrestrial environment. This overview provides the framework for discussing the underlying concepts of mathematical models that have been developed both as research tools (to help better understand the terrestrial system) and as regulatory or management tools (to help assess and control the exposure and risks resulting from chemical use and waste disposal). Model classifications are discussed, selected models are described (PESTAN, SESOIL, PRZM, CREAMS2 and HELP) model selection criteria and guidelines are presented, and model limitations are explored in terms of their ability to represent chemical fate and movement in the soil environment. (See also W89-01859) (Lantz-PTT)
W89-01860

TRANSPORT MECHANISMS AND LOSS PATHWAYS FOR CHEMICALS IN SOIL,
California Univ., Riverside.
W. A. Jury, and R. L. Valentine.
IN: Vadose Zone Modeling of Organic Pollutants. Lewis Publishers, Inc., Chelsea, Michigan. 1986. p 37-60, 5 tab, 67 ref.

Descriptors: *Solute transport, *Soil water, *Path of pollutants, *Fate of pollutants, *Soil water, *Degradation, Mass flow, Liquid diffusion, Vapor diffusion, Hydrodynamic dispersion, Leaching, Volatilization, Biodegradation, Diffusion, Dispersion.

Chemicals are transported through soil principally by three mechanisms: mass flow of dissolved chemical within moving solution, liquid diffusion within soil solution, and gaseous diffusion within soil air voids. The first mechanism, mass flow, refers to the passive transport of dissolved solute within moving soil water which is approximated as the product of the volume flux of water times the dissolved solute concentration. Liquid diffusion refers to the transport of the dissolved solutes within solution by intermolecular collision which move the solute from regions of the higher solute density to lower solute density. Similarly, chemical vapor molecules in the soil air spaces also undergo molecular collisions and spread out by vapor diffusion which is expressed as the product of the vapor density or concentration gradient and a proportionality coefficient called the soil vapor diffusion coefficient. The apparent solute diffusion arising from the mass flux effects which are obscured by mathematical volume averaging is called hydrodynamic dispersion. Chemicals added to a soil profile from the surface may leave the zone of incorporation by one of three loss pathways. The first pathway, known as leaching, takes place principally by mass flow and refers to the downward movement of dissolved chemical. The second loss pathway, volatilization, refers to the loss of chemical vapor to the atmosphere through the soil surface. The final loss pathway, degradation, refers to the biological or chemical transformation of the chemical to a different form with properties distinct from those of the chemical prior to transformation. Each of these loss pathways is discussed in greater detail in this chapter. (See also W89-01859) (Lantz-PTT)
W89-01861

GENERIC STEPS IN THE FIELD VALIDATION OF VADOSE ZONE FATE AND TRANSPORT MODELS,
Environmental Protection Agency, Las Vegas, NV.
For primary bibliographic entry see Field 7C.
W89-01862

EXAMPLE FIELD TESTING OF SOIL FATE AND TRANSPORT MODEL, PRZM, DOUGHERTY PLAIN, GEORGIA,
Environmental Protection Agency, Las Vegas, NV.
K. F. Hedden.
IN: Vadose Zone Modeling of Organic Pollutants. Lewis Publishers, Inc., Chelsea, Michigan. 1986. p 81-101, 3 fig, 8 tab, 25 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Data interpretation, *Soil water, *Model studies, Field tests, PRZM, Dougherty Plain, Georgia, Solute transport, Vadose water.

A major problem for any validation or testing effort is obtaining a data set that has determined the needed parameters and has sampled the appropriate variables for an adequate period of time. The first example described in this chapter is an effort that was designed with the express purpose of testing a particular vadose zone model, PRZM. The steps followed are: (1) Identify Model User's Need; (2) Examine the Model; (3) Evaluate the feasibility of field validation; (4) Develop acceptance criteria for validations; (5) Determine field validation scenario; and (6) Plan and conduct field

validations. This effort is not yet complete, so only the initial stages are described, but should serve to give the reader an idea of what is involved in testing a model. (See also W89-01859) (Lantz-PTT)
W89-01863

EXAMPLE MODEL TESTING STUDIES,
Aqua Terra Consultants, Palo Alto, CA.
For primary bibliographic entry see Field 7C.
W89-01864

CHEMICAL MOVEMENT THROUGH SOIL,
California Univ., Riverside.
W. A. Jury.
IN: Vadose Zone Modeling of Organic Pollutants. Lewis Publishers, Inc., Chelsea, Michigan. 1986. p 135-158, 3 tab, 55 ref.

Descriptors: *Path of pollutants, *Soil water, *Vadose water, *Solute transport, Porosity, Permeability, Clay, Organic matter, Water retention, Temperature, Precipitation, Evapotranspiration, Irrigation practices, Crops.

At this time there have been identified a significant number of soil (water content, bulk density or porosity, permeability (saturated), clay content, surface area, organic matter content, depth to groundwater, and water retention (field capacity)), environmental (temperature, precipitation and evapotranspiration), and management (chemical concentration, irrigation management, crop characteristics) parameters which influence chemical transport through soil, and a large body of information has been assembled for finding the relationship between these parameters and the chemical transport. From years of study under controlled conditions, a substantial theoretical framework has been developed for describing water and chemical transport. This theory uses differential equations developed from a macroscopic mass balance and uses flux equations obtained as an extension to equations which are valid in one phase systems. Chemical transport generally involved liquid, vapor, and adsorbed phases so that a relationship between the phases is also used in addition to the transport equation. Although rate limitations can be expected to alter this equilibrium relation under general conditions, models frequently simplify this using linear equilibrium partition coefficients. For such systems, the three-phase transport may be replaced by an equivalent representation in terms of total concentration using equivalent three-phase transport velocities and dispersion coefficients. (See also W89-01859) (Lantz-PTT)
W89-01865

VOLATILIZATION FROM SOIL,
California Univ., Riverside.
W. A. Jury.
IN: Vadose Zone Modeling of Organic Pollutants. Lewis Publishers, Inc., Chelsea, Michigan. 1986. p 159-176, 2 fig, 2 tab, 28 ref.

Descriptors: *Fate of pollutants, *Soil contamination, *Volatilization, *Evaporation, Porosity, Infiltration, Clay, Temperature, Wind, Evaporation, Irrigation, Precipitation, Diffusion.

Volatilization is defined as the loss of chemicals in vapor form from soil surfaces to the atmosphere. This process is ultimately limited by the chemical vapor concentration which is maintained at the soil surface and by the rate at which this vapor is carried away from the soil surface to the atmosphere. The potential volatility of a chemical is related to its inherent saturated vapor pressure, but the actual volatilization rate from soil in any specific circumstance will depend on all soil, atmospheric, or management factors which influence the behavior of the chemical at the soil-air-water interface. Rate process interactions at the soil surface (soil chemical vapor density and vapor movement from soil to atmosphere), chemical movement from soil to the soil surface (gaseous diffusion; hydrodynamic dispersion; and soil, environmental, and management factors influencing chemical volatilization from soil), soil parameters (soil water content, bulk density or porosity, clay content, and adsorption site density), environmental parameters (temperature, wind, evaporation, and precipitation), and management parameters (chemical concentration, depth of concentration, depth of incorporation, irrigation management, and soil management), are the major points of volatilization discussed in this chapter. (See also W89-01859) (Lantz-PTT)
W89-01866

ADSORPTION OF ORGANIC CHEMICALS ONTO SOIL,
California Univ., Riverside.
W. A. Jury.
IN: Vadose Zone Modeling of Organic Pollutants. Lewis Publishers, Inc., Chelsea, Michigan. 1986. p 177-189, 2 tab, 39 ref.

Descriptors: *Adsorption, *Organic compounds, *Soil contamination, *Path of pollutants, Chemical reactions, Molecular structure, Adsorption, Desorption, Model studies, Soil properties.

Adsorption refers to the bonding of a solute to adsorption sites on the soil solids, either soil mineral surfaces or organic matter surfaces. The effect of this bonding is to temporarily immobilize the molecule from transport in either the solution or vapor phase. In most quantitative descriptions of soil chemical transport processes in soil, the adsorbed molecules are represented as a separate phase, i.e., distinct from vapor or solution phases. Bonding mechanisms, practical limitations to applying adsorption models to field studies (adsorption-desorption hysteresis, influence of soil structure, influence of spatial variability, nonequilibrium adsorption, and linear adsorption models), and field measurement of adsorption parameters, are the focus of discussion in this chapter. (See also W89-01859) (Lantz-PTT)
W89-01867

BIOTRANSFORMATION,
Iowa Univ., Iowa City.
R. L. Valentine, and J. L. Schnoor.
IN: Vadose Zone Modeling of Organic Pollutants. Lewis Publishers, Inc., Chelsea, Michigan. 1986. p 191-222, 3 tab, 93 ref.

Descriptors: *Biotransformation, *Biodegradation, *Path of pollutants, *Soil chemistry, *Fate of pollutants, *Soil bacteria, Kinetics, Hydrogen ion concentration, Temperature, Clay, Nutrients.

The term biotransformation is a general term describing any alteration of a compound affected by living organisms. Biodegradation is a more specific term usually referring to a biologically mediated transformation of a chemical into more simple products by the removal of one or more substituent groups. Neither of these terms expresses the extent of change in the identity of a compound, the mechanisms involved in that change, the rate at which this change occurs, or the species responsible for this change. Information on biological reactions, kinetics of biotransformation, factors influencing biotransformation, availability of the chemical, major factors affecting biodegradation (pH, temperature, water content, carbon content, clay content, oxygen, nutrients, microbial population acclimation, and concentration), estimation of rate parameters and limitations to applying degradation rate expressions, further this discussion on biotransformation. (See also W89-01859) (Lantz-PTT)
W89-01868

NONBIOLOGICAL TRANSFORMATION,
Iowa Univ., Iowa City.
R. L. Valentine.
IN: Vadose Zone Modeling of Organic Pollutants. Lewis Publishers, Inc., Chelsea, Michigan. 1986. p 223-243, 2 tab, 58 ref.

Descriptors: *Soil Chemistry, *Fate of pollutants, *Soil water, Path of pollutants, Vadose water, Photochemistry, Hydrolysis, Oxidation-reduction reactions.

While all processes leading to structural changes in chemicals can be considered as occurring as the result of chemical reactions, these processes can be categorized as being either biological, chemical, or photochemical transformations. Chemical transformations of importance in the soil environment include hydrolysis and oxidation-reduction reactions (Redox reactions). Photochemical transformations can occur only in the presence of light and hence are expected to be important only at or very near the soil surface. (See also W89-01859) (Lantz-PTT)
W89-01869

AQUATIC TOXICOLOGY AND ENVIRONMENTAL FATE: NINTH VOLUME.
American Society for Testing and Materials, Philadelphia, PA.
A Symposium Sponsored by the American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, Pennsylvania, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. 530p. Edited by Ted M. Poston and Rich Purdy.

Descriptors: *Toxicology, *Fate of pollutants, *Toxicity, *Environmental effects, *Aquatic toxicology, Bioaccumulation, Biotransformation, Organic compounds, Bioassay, Biological studies, Trout, Light intensity, Temperature, Nutrients, Monitoring, Symposium.

A major emphasis of this Ninth Symposium on Aquatic Toxicology and Environmental Fate was bioaccumulation and biotransformation of xenobiotics. The ability of aquatic organisms to metabolize toxic chemicals may help establish acceptable levels of exposure for aquatic organisms. Metabolism of several organic compounds were investigated in trout, blue crabs, and bivalve mollusks. In some cases, metabolized compounds may become mutagenic or carcinogenic. Two studies report on the use of the rainbow trout embryo for: (1) metabolism studies, and (2) studies on toxicity, teratogenicity, and carcinogenicity. The data generated from these types of studies not only help understand potential environmental impacts, but also indicate potential hazards to humans. The use of lower organisms and other alternative test systems for assessing the hazards of chemicals to humans was reviewed. The effects of light intensity, photoperiod, temperature, and nutrition on reproduction and survival of Daphnia magna was evaluated with respect to toxicity testing. Quality assurance has emerged as a necessary component of toxicity testing. The quality assurance programs for the hydra reaggregation test and the hydrogen oxidation soil bioassay are covered in this volume. Additional sections of this volume deal with biomonitoring, new test methods, and the relationship between sediment and toxicity and bioavailability of chemicals. As an evolving science, new and innovative methods are constantly being developed to evaluate the toxicity of new chemicals. Specific concerns, such as the influence of environmental factors on toxicity, require the development of specialized test procedures. Binding of toxicants to sediments is the predominant environmental vector for removal of most toxicants from the water column. This process results in accumulations of toxic compounds in sediments, a condition that has caused considerable research activity in the environmental arena. The approaches to deal with this problem involve modeling efforts to predict toxicity based on thermodynamic equilibria of metals to laboratory and field studies focusing on the toxicity of organic compounds to sorbed to organically enriched sediments. (See W89-01893 thru W89-01929) (Lantz-PTT)
W89-01892

DESIGN CRITERIA FOR A PREDICTIVE ECOLOGICAL EFFECTS MODELING SYSTEM,
Environmental Research Lab., Athens, GA.
For primary bibliographic entry see Field 5C.
W89-01896

FACTORS AFFECTING THE ACCEPTANCE AND REJECTION OF GENETICALLY ALTERED MICROORGANISMS BY ESTABLISHED NATURAL AQUATIC COMMUNITIES,

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
J. Cairns, and J. R. Pratt.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 207-221, 3 fig, 1 tab, 36 ref.

Descriptors: *Genetic pollution, *Genetics, *Ecosystems, *Aquatic environment, *Fate of pollutants, Environmental engineering, Aquatic toxicology, Ecological effects, Population exposure.

Unlike toxic chemicals, genetically altered organisms have the potential to move between ecosystems and increase in number. Many organisms used in genetic engineering research are derived from common free-living and pathogenic forms. Establishment of genetically altered species in ecosystems depends on rates of introduction, probability of finding acceptable or optimal conditions, rate of export to other habitats, rate of extinction from suitable habitat, ability to compete with organisms with similar niche requirements, functional compatability with non-competitors, relative stress conditions in the receiving system, and many other factors. In some cases, the introduction of genetically altered species will be accidental (for example, escape from a laboratory or industrial process site). In other cases, release will be part of a management plan (for example, release of organisms to degrade pollutants or produce pesticides). In both cases, it will be important to estimate the fate, survival potential, and probability of adverse ecological effects of any release into the environment. (See also W89-01892) (Author's abstract)
W89-01908

METABOLISM OF BENZO(A)PYRENE BY A MIXED FUNCTION OF OXYGENASE SYSTEM IN BLUE CRABS, CALLINECTES SAPIDUS,
Skidaway Inst. of Oceanography, Savannah, GA.
For primary bibliographic entry see Field 5C.
W89-01910

BIOTRANSFORMATION OF BENZO(A)PYRENE BY MERCENARIA MERCENARIA AND CRASSOSTREA VIRGINICA,
Sloan-Kettering Inst. for Cancer Research, New York.
For primary bibliographic entry see Field 5C.
W89-01911

BIOCONCENTRATION, DETOXIFICATION, AND EXCRETION OF MUTAGENIC RIVER POLLUTANTS IN FISH BILE,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. of Mutagenesis and Carcinogenesis.
C. F. Van Kreijl, D. De Zwart, and W. Slooff.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 268-276, 4 fig, 19 ref.

Descriptors: *Toxicology, *Fate of pollutants, *Water pollution effects, *Aquatic toxicology, *Bioaccumulation, *Fish physiology, *Rhine River, *Bile, *Mutagenicity, Organic compounds, Rainbow trout, Aromatic compounds.

The continuous presence of unknown Salmonella mutagens in XAD-concentrates of Rhine river water has been shown in previous studies. Using nitro-reductase deficient bacterial strains and silica fractionation, this study strongly indicates that the responsible compounds may consist of nitro substituted aromatics (with additional polar groups or heterocyclic structures) and aromatic amines. The same type of mutagens could be detected (10,000-fold) in the bile of rainbow trout exposed to Rhine river water. Considering the accumulated mutagenic activity in natural occurring fish, this observation argues in favor of a true bioconcentration process of water-borne mutagens in fish bile. The clearance of mutagenic activity of bile after transferring the fish to clean water again is indicative for the importance of biliary excretion of xenobiotics and their metabolites. (See also W89-01892) (Author's abstract)
W89-01913

INFLUENCE OF AGE ON PATTERNS OF UPTAKE AND EXCRETION OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE RAINBOW TROUT EMBRYO,
Washington Univ., Seattle. School of Medicine.
R. G. Stahl, and R. M. Kocan.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 287-303, 3 fig, 6 tab, 23 ref.

Descriptors: *Path of pollutants, *Toxicology, *Aromatic compounds, *Aquatic toxicology, *Hydrocarbons, *Rainbow trout, *Embryos, *Water pollution effects, Bioassay, Metabolism, Fish physiology, Benzo(a)pyrene, Organic compounds.

An investigation of the uptake, metabolism, and excretion of benzo(a)pyrene (B(a)P) and its metabolites in developing rainbow trout embryos and larvae, as well as the effects of mixed function oxygenase (MFO) inducers on these processes, has been conducted. The time of exposure during development has a significant effect on the rate of uptake and excretion, and MFO inducers can significantly influence the rate of excretion of the metabolites. In addition, the appearance of measurable B(a)P monooxygenase activity is related to the embryo's developmental stage, and embryonic trout metabolize B(a)P to compounds similar to those produced by adult fish and mammals. (See also W89-01892) (Author's abstract)
W89-01915

BIOCONCENTRATION OF HYDROPHOBIC CHEMICALS IN FISH,
Amsterdam Univ. (Netherlands). Lab. of Environmental and Toxicological Chemistry.
A. Opperhuizen.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 304-315, 4 fig, 2 tab, 19 ref.

Descriptors: *Path of pollutants, *Aquatic toxicology, *Toxicology, *Hydrophobicity, *Organic compounds, *Fish, *Bioconcentration, Bioaccumulation, Polychlorinated biphenyls, Model studies, Dioxin, Fish physiology.

Uptake rate constants by fish of di-, tetra-, hexa-, octa-, and decachlorobiphenyls are independent of the solute's hydrophobicity. By combining a two-compartment bioconcentration model with a modified membrane permeation model, simple relationships between uptake rate constants into fish and the solutes' hydrophobicities and molecular configurations are obtained. The observed lack of uptake by fish of hexabromobenzene, octachloronaphthalene, and octachlorodibenzo-p-dioxin is not due to insufficient exposure concentrations, since the exposure concentrations of these compounds in the continuous flow water saturation system were significantly higher than those of some polychlorinated biphenyls (PCB) congeners. Lack of uptake of these chemicals can be explained by proposing an influence of membrane permeation on the mechanism of bioconcentration. For these compounds, it is shown that size rather than octan-1-ol/water partition coefficients or aqueous solubility causes a lack of uptake by fish. (See also W89-01892) (Author's abstract)
W89-01916

EFFECT OF NATURAL WATER SOURCE ON THE TOXICITY OF CHEMICALS TO AQUATIC MICROORGANISMS,
Smith Kline and French Labs., King of Prussia, PA.
For primary bibliographic entry see Field 5A.
W89-01925

AQUATIC TOXICOLOGY AND HAZARD ASSESSMENT: SEVENTH SYMPOSIUM.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 5C.
W89-01930

SEDIMENT MICROBIAL ACTIVITY TESTS FOR THE DETECTION OF TOXICANT IMPACTS,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
For primary bibliographic entry see Field 5A.
W89-01944

USING THE NATURAL DETOXIFICATION CAPACITIES OF MARINE ORGANISMS TO ASSESS ASSIMILATIVE CAPACITY,
Southern California Coastal Water Research Project Authority, Long Beach.
D. A. Brown, S. M. Bay, and R. W. Gossett.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 364-382, 7 fig, 2 tab, 64 ref. NOAA/OMPA Grants NA80RAD00040 and NA82RAD00003.

Descriptors: *Toxicology, *Biodegradation, *Path of pollutants, *Fate of pollutants, *Water pollution effects, *Bioaccumulation, *Aquatic toxicology, *Detoxification, Chemical analysis, Enzymes, Marine environment, Cadmium, Copper, Zinc, Heavy metals, Tissue analysis, Toxicity.

A test for determining the toxicity of contaminants in the environment is described, with a proposal that this test can be used to determine assimilative capacity for some contaminants. This test is based upon the observation that organisms have a measurable capacity to internally detoxify, and thereby safely assimilate, metal and organic contaminants. Toxic effects of contaminants appear to coincide with saturation of in vivo detoxification systems with metal or organic contaminants and appearance of these contaminants at intracellular sites of toxic action. A simple gel chromatography procedure has been devised to determine the intracellular partitioning of contaminants between an enzyme-containing (ENZ) pool which is a site of toxic action for both metals and organic compounds, a metallothionein-containing (MT) pool which is a site of detoxification for metals, and a glutathione-containing (GSH) pool which is a site of detoxification for organic compounds. Several marine species including sea urchins, scorpion fish, croakers, and Dover sole were sampled from populations living near and away from a major California municipal wastewater outfall, and the partitioning of contaminants between intracellular pools was determined. Cadmium, copper, and zinc appeared to be successfully detoxified by the MT pool in all field-exposed organisms. Oxygenated metabolites appeared to have exceeded the capacity of the GSH pool in field-exposed croakers and Dover sole, with fatty livers and fin erosion, respectively. Therefore, at present levels of contamination of southern California coastal waters, the detoxification (assimilative) capacity of some marine organisms for certain trace metals does not appear to have been exceeded, whereas that for organic contaminants has. Sediments and their associated microorganisms were also suggested to have a measurable capacity to detoxify contaminants by binding them so that they are not bioavailable or by degrading them to nontoxic forms. (See also W89-01930) (Author's abstract)
W89-01953

MODEL FOR PREDICTING THE INFLUENCE OF SUSPENDED SEDIMENTS ON THE BIOAVAILABILITY OF NEUTRAL ORGANIC

CHEMICALS IN THE WATER COMPARTMENT,
Monsanto Co., St. Louis, MO.
For primary bibliographic entry see Field 7B.
W89-01956

AQUATIC SAFETY ASSESSMENT OF CHEMICALS SORBED TO SEDIMENTS,
Monsanto Co., St. Louis, MO.
W. J. Adams, R. A. Kimerle, and R. G. Mosher.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 429-453, 1 fig, 9 tab, 21 ref.

Descriptors: *Toxicology, *Aquatic toxicology, *Pesticides, *Sediment contamination, *Fate of pollutants, *Water pollution effects, *Bioassays, Kepone, Bioaccumulation, Midges, Population dynamics, Toxicity, Hazard assessment.

Chemical safety is assessed by the relationship of toxic effects to exposure concentrations, that is, by defining the margin of safety. Studies to define the key route of exposure (interstitial water, water column water, sediment or food) were conducted with Kepone and the midge, Chironomus tentans, in partial life cycle static and flow-through tests. The endpoints measured were survival, growth, and bioaccumulation. Seven 14-day tests were conducted. The no effect-effect concentrations for midges exposed to Kepone in the water were > 5.4 < 11.8 ppb. No effects were observed when the midges were fed food containing up to 17,900 ppb Kepone. In the sediment exposure studies, the no-effect concentrations varied from 3000 to 36,000 ppb depending upon the organic carbon content of the sediment. In all the sediment exposure studies, water column concentrations were below the sediment interstitial column effect levels (11.8 ppb), and effects were observed only when the sediment interstitial column concentrations exceeded the 11.8 ppb water column exposure chronic effect level. Measured bioaccumulation factors for each study showed little variability when the midge tissue concentrations were divided by the sediment interstitial water concentrations. It can be concluded from these studies with Kepone and C. tentans, that the key route of exposure is from the interstitial water and/or the water at the sediment/water interface. Toxic effects can be expected to occur in benthic invertebrates only if the chemical concentration is high enough in the sediments such that the equilibrium interstitial water concentration reached by desorption is equal to or higher than the concentration demonstrated to cause an effect in a water exposure test. Interpretation of aquatic hazard and calculation of safety factors for nonionic organic chemicals sorbed to sediments should be based on the concentration of the chemical in the sediment interstitial water, which is a function of the chemical's sediment partition coefficient (K sub p), concentration of chemical on the sediment, and the organic carbon content of the sediment. (See also W89-01930) (Lantz-PTT)
W89-01957

ROLE OF SEDIMENT ORGANIC MATTER ON SORPTION-DESORPTION REACTIONS AND BIOAVAILABILITY OF MERCURY AND CADMIUM IN AN INTERTIDAL ECOSYSTEM,
Battelle New England Marine Research Lab., Duxbury, MA.
R. J. Breteler, and F. I. Saksa.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 454-468, 3 fig, 5 tab, 32 ref. Corporate Technical Development of Battelle Memorial Inst. Contract B-1333-1411.

Descriptors: *Sorption, *Sediments, *Bioavailability, *Aquatic toxicology, *Path of pollutants, *Toxicology, *Mercury, *Cadmium, *Bioaccumulation, *Fate of pollutants, Ecosystems, Adsorption, Salt marshes, Mussels, Model studies, Tissue analysis, Regression analysis, Organic matter.

The adsorption-desorption behavior and bioavailability of mercury and cadmium in a model salt marsh ecosystem have been investigated. Specimens of two species of filter-feeding mussels, Mytilus edulis and Modiolus demissus, were placed in large rectangular enclosures containing marsh peat previously equilibrated with a seawater solution of the metals. The tissue concentration was determined after 21 and 70 days. Correlation between the levels of these metals in mussel tissue and the following parameters were examined: percent total organic matter, sediment metal concentration, acid leachable metal concentration, and amounts of metal desorbed from the sediment. Multiple regression analysis indicated a strong dependence of sorption-desorption processes on sediment organic matter content for both metals. Uptake of mercury was found to depend primarily on the amounts of acid leachable metal and the amounts of metal desorbed from the sediment. Cadmium uptake depended primarily on percent total sedimentary organic matter and the amounts of metal desorbed. (See also W89-01930) (Author's abstract)
W89-01958

EFFECT OF PHYSICOCHEMICAL FORM ON COPPER AVAILABILITY TO AQUATIC ORGANISMS,
Lawrence Livermore National Lab., CA. Environmental Sciences Div.
F. L. Harrison.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 469-484, 1 fig, 10 tab, 42 ref. DOE Contract W-7405-Eng-48.

Descriptors: *Path of pollutants, *Bioavailability, *Toxicology, *Aquatic toxicology, *Copper, *Bioaccumulation, Bluegills, Tissue analysis, Metalloproteins.

Copper concentration and speciation were determined in influent and effluent waters collected from eight power stations that used copper alloys in their cooling systems. Quantities of copper associated with particles, colloids, and organic and inorganic ligands differed with the site, season, and mode of operation of the station. Under normal operating conditions, the differences between influent and effluent waters were generally small, and most of the copper was in bound (complexed) species. However, copper was high in concentration and present in labile species during start-up of water circulation through some cooling systems and during changeover from an open- to a closed-cycle operation. Copper sensitivity of selected ecologically and economically important aquatic organisms was also evaluated. Primary emphasis was placed on acute effects and most of the testing was performed under controlled laboratory conditions. Bluegills collected from the intake and discharge zones of the impoundment and from a control pond were examined for tissue copper concentrations and for the metals associated with metalloproteins in livers. The low molecular weight (LMW) fraction (6000 to 40 000 daltons) contains the metallothionein-like proteins considered to be important in the homeostatis and detoxification of copper; the intermediate molecular weight (IMW) fraction (40 000 to 126 000 daltons) and the high molecular weight (HMW) fraction (126 000 to > 670 000 daltons) contain metalloenzymes required for metabolic processes. In all samples of fish, the LMW fraction contained by far the largest amount of copper. Comparison of the quantities of copper in the LWM, IMW, and HMW fractions shows that copper concentrations were much higher in fish from the intake and discharge sites than from the control site. The mean of the copper concentrations in the LMW fraction from the ten fish from the discharge site was twenty times greater than that in those from the control site; the mean from the intake site was six times greater. (See also W89-01930) (Lantz-PTT)
W89-01959

BIOAVAILABILITY OF TRACE METALS IN NATURAL WATERS,
Illinois Inst. of Tech., Chicago. Pritzker Dept. of Environmental Engineering.
J. R. O'Donnel, B. M. Kaplan, and H. E. Allen.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 485-501, 2 fig, 2 tab, 75 ref.

Descriptors: *Toxicology, *Aquatic toxicology, *Bioavailability, *Metals, *Natural waters, *Path of pollutants, Chemical analysis, Toxicity, Sediments, Bioassays.

Current data on the toxicity of metals to aquatic organisms show effect levels over many orders of magnitude of total metal concentrations. Thus it appears that the bioavailability of metals is not related to this parameter. From solution, toxicity is a function of the concentration of the free metal ion and some hydrolyzed species. From sediments, metal availability is not well understood, although recent work has indicated that metal bound in specific sediment compartments or phases may be the toxic form. The relationship between water quality and the availability of metals to organisms is examined. The chemistry and measurement of metal species should be used as the basis for reviewing bioassay results. Further research needs to be conducted to elucidate the portion of sediment-bound metal which is bioavailable. Problems in the interpretation of bioassay results for natural waters arise from the addition of metal in excess of the capacity of organic ligands for complexation and in not allowing reactions to attain equilibrium. (See also W89-01930) (Lantz-PTT)
W89-01960

BIOLOGICAL DEGRADATION OF COMPLEX IRON CYANIDES IN NATURAL AQUATIC SYSTEMS,
Liesch (Bruce A.) Associates, Inc., Iowa City, IA.
K. L. Cherryholmes, W. J. Cornils, D. B. McDonald, and R. C. Splinter.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 502-511, 4 fig, 5 tab, 7 ref.

Descriptors: *Aquatic toxicology, *Path of pollutants, *Toxicology, *Fate of pollutants, *Biodegradation, *Iron cyanides, *Cyanide, *Natural waters, Chemical analysis, Bacteria.

Iron cyanide complexes have been considered to be very stable when protected from light. However, it was observed in the current study that when aqueous solutions of potassium hexacyanoferrate (III) were seeded with bacteria, concentrations of free cyanide were detected within four days which were as much as 88 times greater than those observed in sterile control solutions. This is significant in terms of aquatic toxicology, since the 200 to 250 micrograms/L LC sub 50 value for free cyanide for many fish species was exceeded. (See also W89-01930) (Author's abstract)
W89-01961

ENVIRONMENTAL IMPACT AND SIGNIFICANCE OF PESTICIDES,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5C.
W89-01969

ORGANOPHOSPHORUS PESTICIDES,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5A.
W89-01975

CARBAMATE PESTICIDES,
Ontario Ministry of Agriculture and Food, Guelph. Pesticide Residue Lab.
For primary bibliographic entry see Field 5A.
W89-01978

SUBSTITUTED UREA HERBICIDES,
Agriculture Canada, Regina (Saskatchewan). Research Station.
For primary bibliographic entry see Field 5A.
W89-01979

TRIAZINE HERBICIDES,
Agriculture Canada, Regina (Saskatchewan). Research Station.
For primary bibliographic entry see Field 5A.
W89-01980

TECHNICAL REVIEW OF THE FACTORS AFFECTING THE AQUATIC USE OF DICAMBA,
E. O. Gangstad.
IN: Environmental Management of Water Projects. CRC Press, Inc., Boca Raton, FL. 1987. p 109-115, 27 ref.

Descriptors: *Dicamba, *Herbicides, *Fate of pollutants, *Environmental effects, Vegetation, Biodegradation, Weed control, Hardwood, Conifers.

Dicamba (Banvel) is a selective herbicide that kills most of the economically significant broadleaf weeds without injury to most grasses. The chemical rapidly penetrates the waxy surfaces of leaves and stems. The herbicide moves in the phloem system throughout the entire plant, destroying tissue as it moves. It can eliminate tough broadleaf weeds and brush, including deep-rooted, hard-to-kill perennials, and those resistant to or merely suppressed by phenoxy compounds. It gives lasting control at all plant-growing temperatures and does not require specific weather conditions to kill actively growing weeds. Only one application is needed to provide full-season control. Degradation studies of dicamba herbicide in soil and water show that it is biodegradable. If done correctly, this type of application can provide excellent control of most hardwoods and conifers as well as many vines, broadleaf weeds, and other stream bank vegetation. (See also W89-01990) (Lantz-PTT)
W89-01999

MANUFACTURED GAS WASTE DISPOSAL INVESTIGATIONS. TWO CASE STUDIES IN IOWA,
Wisconsin Dept. of Natural Resources, Madison.
S. Bangert, D. B. McDonald, S. J. Prior, and S. J. Tuthill.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 39-51, 5 fig, 6 tab, 6 ref.

Descriptors: *Groundwater pollution, *Path of pollutants, *Case studies, *Waste disposal, Iowa, Groundwater pollution, Drinking water, Water quality, Aromatic compounds, Hydrocarbons, Groundwater management, Drainage, Coal gasification, Phenols.

Two of Iowa Electric Light and Power Co. (Iowa Electric) predecessor companies operated coal gasification plants in Belle Plaine, Iowa, and Fairfield, Iowa, during the late nineteenth century. Two gas manufacturing processes were used at these plants. The primary concern of the investigation in each community was the evaluation of drinking water supplies and surface water resources in the vicinity of the plant sites. The location of tar residues at each plant site was successfully identified during interviews with former employees of Iowa Electric. Both sites utilized either concrete or wood gravity separators to remove tar from the process water; much of the tar produced at the site over the years had been sold. The excess tar that was not sold was placed in earthen pits. The locations of these disposal sites were verified during the field investigations. The location of the spent oxide disposal site was identified at Belle Plaine, but not at the Fairfield facility. Based on the nature of the soil types and sequences of unconsolidated sediments identified at the sites prior to the field investigations, off-site migration of PAHs and metals associated with the manufactured gas constituents was initially considered to be unlikely. Since benzene, toluene, and xylene and phenols are mobile in soils and groundwater, these compounds were expected to migrate over time. However, field investigations revealed site specific conditions which resulted in the off-site migration of both types of coal gasification waste. Subsurface movement has occurred through shallow (10-30 ft) sand seams located at each site. This movement has probably been enhanced through disturbance of soils at the sites during subsequent construction activities, and the presence of drain tiles along the foundations of the gas holders. While the coal tar constituents moved relatively quickly through the sand seams, the initial information from the Belle Plaine site investigation indicated these constituents do not migrate rapidly through silts. The extent of both the horizontal and vertical off-site migration from each plant has yet to be determined. (See also W89-02006) (Lantz-PTT)
W89-02011

LEACHABILITY OF SOLIDIFIED (BA, RA)SO4 SEDIMENTS IN SIMULATED SETTLING PONDS,
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
T. W. Constable, and W. J. Snodgrass.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 67-73, 7 fig, 2 tab, 5 ref.

Descriptors: *Radioactive wastes, *Leaching, *Barium, *Radon, *Sulfates, *Sediments, *Settling ponds, *Water pollution prevention, *Path of pollutants, Pore water, Diffusion, Solidification, Calcium, Magnesium, Barium, Effluent streams, Solute transport.

The leaching of Ca, Mg, SO4 and 226-Ra from (Ba, Ra)SO4 sediments is consistent with dissolution reactions in sediment pore water and the diffusion of these constituents into the overlying water. Leaching from solidified sediments is consistent with the dissolution of a (Na, K)-(silicate, sulfate) solid that is partially capable of suppressing dissolution of 226-Ra and (Ca, Mg, Ba) sulfate, which are the main constituents of the sediments. Solidification decreased the amount of dissolved 226-Ra released from the ponds during the study by about 65%. The increase in calcium concentrations in the solidified sediment effluents suggests that the encapsulating material may be slowly dissolving. The results of this study, and of a similar study conducted on solidified tailings, suggest that solidification of tailings and (Ba, Ra)SO4 sediments by the Chemfix process may only delay the release of radionuclides and other constituents from these residues, but no prevent this release from eventually occurring. (See also W89-02006) (Lantz-PTT)
W89-02013

BIODEGRADATION OF ORGANIC COMPOUNDS IN ANOXIC GROUNDWATER SYSTEMS,
Black and Veatch, Philadelphia, PA.
For primary bibliographic entry see Field 5G.
W89-02027

BINDING CHARACTERISTICS OF HAZARDOUS ORGANIC SUBSTANCES TO CLAY SOILS,
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
G. A. Selvakumar, A. M. Rodrigo, and P. Chan.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 775-780, 8 fig, 2 tab, 8 ref.

Descriptors: *Hazardous wastes, *Organic compounds, *Clays, *Binding, *Fate of pollutants, *Path of pollutants, Illite, Phenol, Chlorophenol, Chlorobenzene, Sorption, Adsorption.

Disposed liquid organic contaminants may percolate through the vadose zone and reach the water bearing aquifers. During the migration of contaminants towards the water bearing aquifers, the contaminants are constantly in contact with the soil. Certain chemicals that are hydrophobic and nonreactive in nature cause more affinity to solid particles than that of water. In the case of clay soils, the negative surface charges tend to bind dipolar organic compounds to form a diffuse electrical double layer. The degree to which the liquid organic contaminants are bound to the clay particles is one of the key factors which controls the contaminant transport. Bentonite, illite and kaolinite were selected for the study of sorption characteristics. Only the results obtained on illite are presented in this paper. Illite is crystalline in form and commonly found in soils and aquatic sediment. The sample was ground using a handmill and passed through a U.S. No. 40 sieve before it was used in the experimental analysis. A significant amount of phenol, chlorophenol and chlorobenzene was sorbed by illite. These processes reach equilibrium within the first 0.5 to 2 hours, depending upon the type of liquid organic. The optimum detention time decreases as the solubility of the contaminant increases. The Freundlich adsorption isotherm best depicted the equilibrium adsorption process of these liquid organic contaminants on to illite. Hydrophobic and high polar compounds exhibit greater sorption on to illite compared to that of hydrophobic compounds. Considerable amounts of desorption of liquid organic contaminants were observed during the washing. Results show that for compounds with a high adsorption rate and capacity, the desorption was found to be small and vice-versa. The removal of contaminants ceases after a few washings of the clay samples. This shows the existence of reversible and irreversible components of sorption. (See also W89-02006) (Lantz-PTT)
W89-02081

SORPTION OF 2,4-DICHLOROPHENOL AND 1,1,1-TRICHLOROETHANE ONTO THREE SOILS,
Rutgers - The State Univ., Piscataway, NJ. Dept. of Chemical and Biochemical Engineering.
W. M. Ollinger, and R. C. Ahlert.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 781-785, 3 fig, 3 tab, 5 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Dichlorophenol, *Trichloroethane, *Sorption, *Soil types, Clay, Loam, Model studies, Mathematical analysis, Linear analysis, Sand.

An experiment was performed to estimate the equilibration period for the sorption of 2,4-dichlorophenol onto a loam soil. Results indicate that a steady-state concentration was obtained in a period of 24 hr. Contact periods for all subsequent batch experiments were between 24 hr. and 72 hr. Sorption data was modeled using linear and linearized Langmuir and Freundlich isotherms. The nonlinear sorption models may be linearized by logarithmic and reciprocal transformations of the set (q,C) for the Freundlich and Langmuir models, respectively. Alternatively, a non-linear regression procedure can be employed. Parameter estimates for linear, Freundlich and Langmuir isotherms for the sorption of 2,4-dichlorophenol onto a sandy loam and loam are given, as are the parameter estimates for the sorption of trichloroethane (TCA) on the sandy clay loam and loam appear. Significant non-zero intercepts for the linear model were obtained for those experiments involving 2,4-dichlorophenol. These results imply that a linear model is not valid for this solute. The intercepts for the linear and Langmuir models were not statistically different from zero at the 95% confidence interval for the solute 1,1,1-TCA. These results support the hypothesis of linear partitioning and suggest, somewhat improbably, that the sorbents have infinite sorption capacities for this solute. Since the arguments of the concentrations exponents were not significantly different than unity, the linear model was chosen to describe the sorption of TCA. The higher sorptive affinity of the

organic rich sorbent for TCA is evident. The normalized linear partition coefficient estimates are 44.9 and 44.0 for the sandy clay loam and loam, respectively. (See also W89-02006) (Lantz-PTT)
W89-02082

HEAVY METALS IN WASTEWATER AND SLUDGE TREATMENT PROCESSES. VOLUME I: SOURCES, ANALYSIS, AND LEGISLATION.
For primary bibliographic entry see Field 5A.
W89-02097

SCOPE OF THE PROBLEM,
Consultants in Environmental Sciences Ltd., London (England).
For primary bibliographic entry see Field 5C.
W89-02098

SOURCES OF HEAVY METALS IN WASTEWATER,
Teesside Polytechnic, Middlesbrough (England). Dept. of Chemical Engineering.
T. Stephenson.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume I: Sources, Analysis, and Legislation. CRC Press, Boca Raton, Florida, 1987. p 31-64, 7 fig, 12 tab, 124 ref.

Descriptors: *Heavy metals, *Water pollution sources, *Wastewater, Wastewater treatment, Domestic wastes, Industrial wastes, Runoff, Air pollution.

Sources of metals that enter the water environment can be divided into two main categories: those that originate from man's activities and those of natural origin. Sources of metals that can eventually reach wastewater treatment works can be considered as five types: domestic and industrial effluents, runoff, atmosphere, and lithosphere. Domestic and industrial discharges are probably the two most important anthropogenic sources, and anthropogenic metals may also come from the atmosphere and runoff, depending on whether the sewerage system is separate or combined with storm drainage. Nonanthropogenic sources can also include the atmosphere and runoff, the latter arising from geochemical background concentrations due to sources in the lithosphere. Further refinement of specific sources within each source type is given along with the interrelationship of the major sources of heavy metals and the possible pathways to wastewater treatment processes. (See also W89-02097) (Lantz-PTT)
W89-02099

CHEMICAL SPECIATION OF HEAVY METALS IN SEWAGE SLUDGE AND RELATED MATRICES,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
D. L. Lake.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume I: Sources, Analysis, and Legislation. CRC Press, Boca Raton, Florida, 1987. p 125-153, 5 fig, 6 tab, 142 ref.

Descriptors: *Sludge, *Heavy metals, *Speciation, *Chemical analysis, *Path of pollutants, Fulvic acids, Humic acids, Solubility, Degradation, Sulfides, Phosphates, Carbonater.

Metals may occur in sewage sludges as soluble, adsorbed, organically complexed, precipitated, coprecipitated in metal oxide, or residual forms. Soluble metals may exist in solution as simple ionic forms, or complexed to soluble organics and inorganics. Complexes with multidentate ligands are generally more stable than those with monodentate ligands. Humic acids and fulvic acids are examples of multidentate ligands found in sludges. The ability of these compounds to form stable complexes with metal ions is undoubtably due to their high content of the electron-donating ligands. Organically complexed metals incorporate those forms which are bound to insoluble organic matter, in addition to components of living cells, their exudates, and a spectrum of degradation products, by simple complexation or chelation. Segregation of heavy metals in sewage sludges into all-specific physicochemical forms is not possible, however, with current analytical techniques. This is due not only to the limitation of analytical techniques available but also to the complex nature of sewage sludges samples. Valuable information on the partitioning of heavy metals in such a complex matrix into several component fractions has been obtained, using chemical-extraction techniques based on selective chemical reagents. Such techniques may either be of a discrete nature, employing a single selective reagent to release a specific metal fraction from within the sludge sample or may incorporate several reagents of increasing extraction strength to release a number of different metal forms in sequence. This fundamental classification into discrete and sequential types provides a basis for discussion of chemical-extraction techniques. (See also W89-02097) (Lantz-PTT)
W89-02102

PHYSICAL AND ELECTROCHEMICAL SPECIATION,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W89-02103

METHODS FOR RECOVERING VIRUSES FROM THE ENVIRONMENT.
For primary bibliographic entry see Field 5A.
W89-02111

MECHANISMS OF ADSORPTION AND ELUTION OF VIRUSES TO SOLIDS IN THE NATURAL ENVIRONMENT,
California Dept. of Health Services, Berkeley. Div. of Labs.
G. W. Fuhs.
IN: Methods for Recovering Viruses from the Environment. CRC Press, Inc., Boca Raton, Florida, 1987. p 139-177, 6 fig, 9 tab, 111 ref.

Descriptors: *Adsorption, *Elution, *Viruses, *Path of pollutants, Solids, Microbiological studies, Particulate matter, Chemical properties, Wastewater treatment.

Virus adsorption to natural materials is a well-studied phenomenon, yet there are still errors of approximately one order of magnitude, in each direction, in the mathematical predictions of viral adsorption. This is understandable if the complexity of natural surfaces and the variability of the aqueous environment are considered. As is shown in this review, most if not all observations are found to support the DLVO (after Derjaguin and Landau and Verwey and Overbeek) theory of interaction of charged colloids, where the major forces at work are London-van der Waals and coulombic (electrostatic double-layer) forces. Incomplete characterization of viral surface properties in dilute aqueous media introduces major uncertainties into the prediction of virus-adsorptive behavior. Some conclusions on the control of environmental viruses can be drawn and certain recommendations can be made: (1) The predictions of the DVLO theory are qualitatively useful despite uncertainties remaining in the quantitative predictions; (2) The predictions of the theory apply mostly to monodisperse virus particles; (3) London-van der Waals forces and double-layer compression may both be maximized by the use of appropriate substrates and by chemically conditioning the aqueous phase that contains the virus particles. Such treatment may consist of pH adjustments and/or additions of calcium or aluminum ions; (4) Control of viruses is best practiced during treatment of wastewater, rather than potable water; and (5) Removal of viruses by treatment processes is no more difficult than the removal of bacteria; theory even suggests that viruses may be more easily removed by adsorption than larger particles. (See also W89-02111) (Lantz-PTT)
W89-02118

VARIATION IN QUANTIFICATION OF CONCENTRATIONS OF TOXIC CHEMICALS IN FISH FROM THE LAURENTIAN GREAT LAKES: THE GOOD, THE BAD AND THE MANAGEABLE,
Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
J. P. Geisy.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 5-23, 2 fig, 8 tab, 6 ref.

Descriptors: *Bioconcentration, *Great Lakes, *Fish, *Sampling, *Chemical aalysis, *Water analysis, *Variability, Population exposure, Quantification, Mathematical studies.

A great amount of variation has been observed in the concentrations of toxic chemical in fishes from the Laurentian Great Lakes. This variation has made it difficult to interpret the results of monitoring programs, determine the probability of exposure in determining the dose portion of hazard assessments for human consumption of fishes from the Laurentian Great Lakes and study the relationships between residue concentrations and adverse effects in populations of fishes. The 'among-fish' variability is due to the nature of the fish, which is caused by many factors, such as: differences in age, size, sex, nutritional status, location and genetic makeup. The 'among-fish' variation of concentrations of toxic chemicals in the Laurentian Great Lakes has been observed to range from as little as two-fold to over 50-fold. The average range in concentrations for most species and most chemicals is approximately 10-fold. The experimenter has no control over how much concentrations of toxic chemicals vary from one fish to another. 'Within-fish' variability, on the other hand, is caused by variation in sampling, weighing and quantifying residue concentrations. The 'within-fish' variation is the type of variation, which has been considered to be adverse. The experimenter wants to know the relative magnitude of the 'within-fish' to that of the 'among-fish' variation. This will determine the degree of resolution about questions which can be asked. Methods available to investigate the variation in concentrations of toxic chemicals and the design of appropriate sampling programs, so that the data obtained is interpretable, are presented. The methodology for determining the sample size and the appropriate number of replications of extractions and quantifications is discussed. Examples of residues in tissues of fish from the Laurentian Great Lakes are used. (See also W89-02121) (Lantz-PTT)
W89-02122

ECOSYSTEM SURPRISE: TOXIC CHEMICAL EXPOSURE AND EFFECTS IN THE GREAT LAKES,
ELI-Eco Logic, Inc., Acton (Ontario).
For primary bibliographic entry see Field 5C.
W89-02123

LONG-RANGE TRANSPORT OF ORGANOCHLORINES IN THE ARCTIC AND SUB-ARCTIC: EVIDENCE FROM ANALYSIS OF MARINE MAMMALS AND FISH,
Canadian Wildlife Service, Ottawa (Ontario).
R. J. Norstrom, and D. C. G. Muir.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 83-112, 6 fig, 4 tab, 75 ref.

Descriptors: *Organochlorines, *Arctic regions, *Marine mammals, *Pesticides, *Chlorinated hydrocarbons, *Path of pollutants, Bioconcentration, Seals, Bears, Tissue analysis, DDT, Dieldrin, Toxaphene, Polychlorinated biphenyls.

Eight groups of organochlorines OCs): Tri- to nonachlorobiphenyls S-PCB), DDT and metabolites S-DDT), technical chlordane compounds and metabolites S-CHLOR), hexachlorocyclohexane isomers S-HCH), hexachlorobenzene HCB), dieldrin and toxaphene, all well-known trace atmospheric contaminants, have been identified in fish, ringed seals and polar bears in Canada. Bioconcentration factors and a geographically extensive data

base on OC levels in polar bear fat are used to predict residue levels in fish throughout the Canadian Arctic and sub-Arctic. Levels in fish muscle are low, ranging from 0.0004 mg/kg wet weight) of dieldrin for the Beaufort Sea to 0.011 mg/kg wet weight) of S-PCB for Hudson Bay. Levels of all OCs are highest in Hudson Bay, with secondary peaks in the south-central Canadian archipelago for more water soluble S-HCH and dieldrin, probably due to runoff from land, and in an area near the Arctic Ocean for S-PCB. S-PCB and HCB levels are the most uniformly distributed. S-DDT levels increase steadily from the Beaufort Sea to Baffin Bay, and are twice as high in Hudson Bay as elsewhere, which may reflect ongoing input from Mexico and Central America to the northeast part of North America. Levels of toxaphene in fish were 3-17 times higher than S-PCB levels, but toxaphene was not found in Polar Bears. Published data on OC levels in fish, air, precipitation and water are summarized and compared to these findings. The apparent order of PCB and DDT contamination is; Great Lakes > NW Atlantic Ocean, North Sea and Baltic Sea > NW Pacific Ocean > Arctic Ocean > Antarctic Ocean. The other OCs, especially a-HCH, appear to be more evenly distributed in the northern hemisphere. More measurements of OC levels in Arctic air, snow and water are required in order to determine the relative importance of atmospheric and oceanic transport mechanisms. (See also W89-02121) (Author's abstract)
W89-02126

TOXIC CONTAMINANTS AND BENTHIC ORGANISMS IN THE GREAT LAKES: CYCLING, FATE AND EFFECTS,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
B. J. Eadie, T. F. Nalepa, and P. F. Landrum.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 161-178, 5 fig, 1 tab, 49 ref.

Descriptors: *Toxicity, *Benthic organisms, *Great Lakes, *Fate of pollutants, *Path of pollutants, *Water pollution effects, Bioaccumulation, Polychlorinated biphenyls, Invertebrates, Stress.

Most persistent contaminants in aquatic systems have a strong affinity for particulate matter and eventually become associated with the sediments. This results in elevated concentrations and exposures for the organisms that inhabit the benthic region. There are three consequences of this behavior. First, the organisms, through their stirring and feeding activities (bioturbation), mix the contaminant-laden sediments through a thickness representing several years to decades of sediment accumulation, thereby stretching out the lake's time dependent response to contaminant input. Second, the organisms bioaccumulate contaminant from the sediment-pore water matrix and this material can be passed up the food web. High concentrations of several contaminants (e.g. PCBs, PAHs) have been measured in the benthic invertebrates of the Great Lakes. Their body burden is usually related to local sediment concentrations. Laboratory experiments with the abundant amphipod, Pontoporeia hoyi, indicate the predominant uptake pathway is via water, thus some sediment-water transfer is necessary to explain the field observations. Third, chronic chemical stress from the complex mixture of contaminants may cause shifts in the composition and density of the benthos. Significant changes in the community structure of the Great Lakes benthos have been documented in several area. Because of major transients in the nutrient loadings and productivity of the lakes and the community structure of the fish (predators), it is difficult to quantify the cause/effect link due to contaminants, although abundant circumstantial evidence exists that the benthos community structure is significantly influenced by the chemical quality of the sediments. (See also W89-02121) (Author's abstract)
W89-02128

HUMAN EXPOSURE ROUTES TO PERSISTENT TOXIC CHEMICALS IN THE GREAT LAKES BASIN: A CASE STUDY,
Toronto Dept. of Public Health (Ontario).
K. Davies.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 195-226, 16 tab, 40 ref.

Descriptors: *Health effects, *Toxicity, *Great Lakes, *Case studies, *Chemicals, *Path of pollutants, Food chain, Fate of pollutants, Drinking water.

The main routes of human exposure to persistent toxic chemicals are air, drinking water and food. Occupational exposure can also be significant. It is important to know the relative contributions of these routes to the total body burden so that programs to reduce human exposure can focus on the most significant pathway(s). This paper assesses the relative importance of the three main non-occupational human exposure pathways to selected persistent toxic chemicals in the Great Lakes basin, using Toronto and Southern Ontario as a case study. This has been done by reviewing data on ambient concentrations in air, drinking water and food, and calculating the estimated human exposure from each route. For the chemicals studied, food was the most significant route of exposure, although concentrations were no greater than in food grown in the USA. All detected concentrations were below the Maximum Residue Limits (MRLs) established in the Canadian Food and Drugs Act. (See also W89-02121) (Author's abstract)
W89-02130

HUMAN EXPOSURE TO PERSISTENT AQUATIC CONTAMINANTS: A PCB CASE STUDY,
Michigan Dept. of Public Health, Lansing.
H. E. B. Humphrey.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 227-238, 1 fig, 7 tab, 18 ref.

Descriptors: *Polychlorinated biphenyls, *Human health, *Aquatic environment, *Path of pollutants, *Water pollution effects, Food chains, Fish, Pesticides, Toxicity, Fate of pollutants.

Persistent waterborne contaminants in the North American Great Lakes are of particular interest because human consumption of freshwater fish from these lakes represent a convenient and significant source of exposure to toxic lipophilic compounds. To investigate this, a study cohort of Michigan residents from ten Lake Michigan shoreline communities was established. A total of 572 persons who consumed a median of 38 pounds of fish/yr were compared to 419 randomly selected persons who did not eat fish from the lake. Past and present fish consumption practices, species and cooking preferences and major health indices were recorded for each participant. In addition, the concentration of PCB and nine chlorinated pesticides were measured in human serum and cooked fish preparations. The exposed group had PCB serum concentrations which ranged as high as 400 parts per billion (ppb) with a median level of 21.4 ppb, which was significantly greater than the 6.6 ppb median concentration found in the comparison group. The elevation of PCB and other organochlorine contaminant concentrations were unique to the exposed group and correlated directly with species preference, annual consumption levels and the number of years fish had been consumed. Homologs of PCB with five and six chlorine atoms, some of which are forms with demonstrated toxicity, dominated the pattern of PCB found in cooked fish and human serum. This unique cohort of persons, shown to be exposed to toxic lipophilic waterborne contaminants, provides the opportunity to evaluate whether or not the prolonged retention of contaminants at these levels will produce subtle or delayed illness in humans. (See also W89-02121) (Author's abstract)
W89-02131

LEAD AND MERCURY IN THE MEDITERRANEAN,
Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station.
D. Osborn.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 239-255, 41 ref.

Descriptors: *Path of pollutants, *Water pollution sources, *Lead, *Mercury, *Mediterranean Sea, Pesticides, Polychlorinated biphenyls, Bioaccumulation, Fish.

The main Mediterranean pollution problem - excessive nutrient inputs - was apparently compounded by those associated with high levels of mercury inedible fish and the contamination of sediment and water by other toxic materials such as lead, organochlorine pesticides and PCBs. More recent data suggest that the metal contamination of Mediterranean waters is, on the whole, not greater than that found in other seas, and that Hg and Pb pollution is a local phenomena associated with coastal areas adjacent to population centers and industrial plants. The enigmatic accumulation of Hg by some fish requires further study. Possibly, because of the peculiar hydrology of Mediterranean waters and the prevailing redox potentials of the sediments under various conditions, methyl mercury is made more available to biota in general and to fish in particular. (See also W89-02121) (Author's abstract)
W89-02132

TOXAPHENE: USAGE, AERIAL TRANSPORT AND DEPOSITION,
South Carolina Univ., Columbia. Belle W. Baruch Inst. for Marine Biology and Coastal Research.
T. F. Bidleman, M. T. Zaranski, and M. D. Walla.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 257-284, 7 fig, 5 tab, 72 ref.

Descriptors: *Toxaphene, *Path of pollutants, *Air pollution, *Water pollution sources, Monitoring, Fate of pollutants, Chromatography, Chemical analysis, Mass spectrometry.

In the three years before its ban in November 1982, over 30,000 tons of toxaphene, a complex mixture of polychlorocamphenes (PCC), was applied largely in the southern United States to soybeans, cotton, grain, and as a cattle dip. PCC are atmospherically transported from sites of application to the Great Lakes and remote regions and are widespread contaminants in Great Lakes and marine fish. Toxaphene is carcinogenic in laboratory animals, and concern over potential risks to populations consuming fish in the Great Lakes and Mississippi Delta regions was cited in the decision to cancel toxaphene registrations. Input of PCC to the environment is likely to continue, although at a lower rate. Continued monitoring of PCC in air, precipitation, and organisms is needed to determine loadings and residue trends for the Great Lakes. PCC physical properties are poorly defined, and a better knowledge of their solubilities and vapor pressures is required to formulate precipitation scavenging and gas exchange models. The available data suggest that PCC are washed out of the atmosphere primarily as vapors. Chromatographic patterns of environmental PCC residues are often different from toxaphene standard fingerprints because of physical weathering, chemical degradation, and metabolism. As a result, identifications by electron capture gas chromatography (GC-ECD) are sometimes uncertain. Analytical selectivity can be improved by using gas chromatography - negative chemical ionization mass spectrometry (GC-NCIMS), and quantitative comparisons between GC-ECD and GC-NCIMS would be desirable. (See also W89-02121) (Lantz-PTT)
W89-02133

CONTAMINANTS IN SELECTED FISHES FROM THE UPPER GREAT LAKES,
Michigan State Univ., East Lansing. Inst. of Water

Research.
F. M. D'Itri.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 51-84, 14 fig, 2 tab, 79 ref.

Descriptors: *Great Lakes, *Fish, *Bioaccumulation, *Path of pollutants, Water pollution sources, Salmon, Polychlorinated biphenyls, DDT, Dieldrin, Mercury, Trout, Chub.

As early as 1965, it was apparent that Great Lakes fishes were bioaccumulating relatively large concentrations of agricultural insecticides such as DDT and dieldrin while the bioaccumulation of PCBs was suspected, but not confirmed. By 1969, state and government agencies had begun annual organochlorine contaminant monitoring programs. They constitute the majority of data on Great Lakes fishes. In general, these data show that, between 1965 and 1980, the PCB, total DDT, dieldrin and mercury concentrations in lake trout, bloater chub, coho salmon and chinook salmon as well as other species of fishes have decreased significantly throughout the Great Lakes. This reflects the more stringent controls on point discharges of these contaminants into the water system in the 1970s. Since 1980, however, the concentrations of these contaminants in Great Lakes fish have declined only slightly in many cases, remained relatively constant, or even increased slightly in others. The recent data often exhibit such year-to-year variations that it is not possible to discern trends. One reason may be the uncontrollable variables inherent in a large lakes fish sampling program. Another may be the impact of toxic chemicals from diffuse nonpoint sources such as atmospheric deposition, municipal/industrial effluent discharges, agricultural and urban runoff, reactivation of contaminants from the sediments, and leachate from municipal and industrial landfills. (See also W89-02137) (Author's abstract)
W89-02140

LAKE BIWA, ITS VALUE AND RELATION TO TRIBUTARY STREAMS,
Shiga Univ., Otsu (Japan).
For primary bibliographic entry see Field 2H.
W89-02144

TOXIC CONTAMINATION IN LARGE LAKES. VOLUME III: SOURCES, FATE, AND CONTROLS OF TOXIC CONTAMINANTS.
For primary bibliographic entry see Field 5G.
W89-02155

CONTRIBUTIONS OF URBAN ACTIVITIES TO TOXIC CONTAMINATION OF LARGE LAKES,
KBN Engineering and Applied Sciences, Inc., Gainesville, FL.
C. D. Pollman, and L. J. Danek.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 25-40, 4 fig, 2 tab, 29 ref.

Descriptors: *Toxicity, *Water pollution sources, *Lakes, *Urban runoff, Overflow, Heavy metals, Copper, Zinc, Lead, Pentachlorophenol, Endosulfan, Organic compounds, Inorganic compounds, Suspended solids, Shallow water, Combined sewer overflows, Storm wastewater.

Increasing urbanization of watersheds has resulted in deterioration of the quality of runoff discharged to receiving water bodies. Large lakes of the world are particularly susceptible to urban pollution because of their role as a receptor of urban runoff. In urban regions where stormwater runoff is combined with sanitary sewage prior to treatment, urban runoff contaminant problems are compounded by inadequate design capacity of wastewater treatment facilities to handle the combined flows when rainfall events are appreciable. These combined sewer overflow events (CSOs) can release large quantities of toxic contaminants as well as such contaminants as nutrients and pathogenic bacteria typically associated with sewage. The principal contaminants in urban runoff appear to be the metals Cu, Zn, and Pb which are present largely as a result of automotive activity and corrosion of metallic surfaces and fittings. Organic contaminants such as pentachlorophenol and endosulfan often are present in urban runoff as well. However, organic including PCBs are much less prevalent as a general rule and appear to be less of a contaminant problem as compared to inorganics. (See also W89-02155) (Author's abstract)
W89-02157

SOURCES AND ROUTES OF TOXIC CONTAMINATION FROM MANUFACTURING OPERATIONS,
Shiga Prefectural Dept. of Civil Life and Environment, Otsu (Japan).
F. Fukada.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 41-48, 3 fig.

Descriptors: *Lake restoration, *Water pollution sources, *Path of pollutants, *Japan, *Industrial wastes, *Cleanup operations, *Lake Biwa, *Polychlorinated biphenyls, Water pollution control, Fish, Rice, Compensation, Sediment contamination, Lakes.

Of several factories around Lake Biwa which were using and were responsible for PCB pollution, the largest was a condenser factory. The immediate impact to the environment was caused by PCB in the factory effluent. Pollution extended to waterways to the lake, pounds and rice paddy-fields, and even to rice and fish. It took about ten years before countermeasures against the pollution were fully effected. They consisted of: (1) Removal of PCB from discharged water from the related factory or the suspension of PCB use; (2) Removal of polluted soil to be sealed up in concrete pits; (3) Medical checkup for the residents; (4) Inspection of the factories in the basin using PCB; and (5) Compensation to the people affected by such contamination. The most difficult aspect to settle concerned a consensus that all firms using PCB share responsibility for the pollution and hence the allotment of compensation expense among them for the damage. After this unfortunate experience, Shiga Prefecture began to practice a rigorous control and monitoring program. Limitations of toxic substances in effluent were made as restrictive as those in drinking water. As well a local regulation was modified so that toxic substances cannot be used without Governor's approval. As a result, the concentration of PCB contained in the sediment of Lake Biwa has decreased to 1/20 to 1/40 of the level 15 years ago. (See also W89-02155) (Author's abstract)
W89-02158

CONTRIBUTION OF AGRICULTURAL PESTICIDES TO WORLDWIDE CHEMICAL DISTRIBUTION,
Science and Education Administration, Beltsville, MD. Pesticide Degradation Lab.
P. C. Kearney, A. R. Isensee, and J. R. Plimmer.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 49-60, 3 fig, 5 tab, 11 ref.

Descriptors: *Water pollution sources, *Pesticides, *Agricultural chemicals, Fertilizers, Lakes, Industrial wastes, Monitoring, Organic compounds.

Advances in plant breeding, coupled with extensive use of fertilizers and pesticides, are responsible for the sustained high yields needed to alleviate world food shortages. Where extensive use or manufacturing of pesticides takes place near large lakes, residues can be detected in aquatic biota. Major changes have occurred in the kinds and amounts of pesticides used over the last three decades, and these changes are reflected, in detected aquatic residues. The pesticides industry is about to undergo a massive change in the chemistry of pest control chemicals that will again change the residue picture over the next two decades. An awareness of these changes will alter the direction of monitoring programs and governmental policies regulating use. Worldwide and national pesticide usage and future technologies in the pesticide industry that will directly impact on large lake ecologies are discussed. (See also W89-02155) (Lantz-PTT)
W89-02159

DISPOSAL ACTIVITIES AS A SOURCE OF CONTAMINANTS TO LARGE LAKES,
Waterloo Univ. (Ontario).
G. J. Farquhar, and E. A. McBean.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 61-81, 5 fig, 7 tab, 18 ref.

Descriptors: *Water pollution sources, *Lakes, *Waste disposal, *Solid wastes, *Niagara River, Municipal wastes, Industrial wastes, Geohydrology, Disposal sites, Groundwater movement.

Waste disposal practices include the burial in or discharge to the soil environment of municipal solid waste and industrial wastes, both solid and liquid. The threat which these disposal practices present for large lakes ranges from none in some situations to serious in others. The factors which influence the extent of the threat include the type and amount of waste being disposed of, the proximity of the site to lakes or their tributaries, the manner in which the disposal site has been designed and operated, the hydrogeologic conditions at the site and the climate. In North America, many disposal sites consist of landfills for municipal solid wastes located 1 km or more from surface waters and operated so as to minimize surface runoff of contaminants. The risk of large lake contamination from this type of site is very limited. However, some disposal sites contain large amounts of hazardous contaminants with access to nearby surface waters through either surface runoff or subsurface flow in highly permeable soil or rock formations. The risk of contamination from these sites is high, especially in cases where the amount of the contaminant disposed of is measured in tons while the allowable aqueous phase contaminant concentration is in the micrograms/L range. The Niagara River situation is a case in point. Current technology available for controlled disposal sites does much to minimize the risks involved. (See also W89-02155) (Author's abstract)
W89-02160

SIGNIFICANCE OF ATMOSPHERIC INPUTS OF TOXIC MATERIALS TO LARGE LAKES,
De Paul Univ., Chicago, IL. Dept. of Chemistry.
For primary bibliographic entry see Field 5C.
W89-02161

TRANSFER OF TOXIC SUBSTANCES AT THE AIR-WATER INTERFACE - INTRODUCTION AND EXAMPLES FROM THE NORTH SEA,
University of East Anglia, Norwich (England). School of Environmental Sciences.
P. S. Liss.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 213-224, 3 fig, 4 tab, 10 ref.

Descriptors: *Path of pollutants, *Air-water interfaces, *Water pollution sources, *North Sea, *Air pollution, Trace metals, Organic compounds, Heavy metals, Arsenic, Cadmium, Copper, Chromium, Mercury, Nickel, Lead, Zinc, Aromatic compounds, Pesticides, Polychlorinated biphenyls, Precipitation.

Chemicals transferring across natural air-water interfaces can be in gas, liquid or solid phases. Parameterization of these modes of exchange is discussed in terms of transfer and deposition velocities, for gaseous and solid phase exchange respectively, and washout factors for deposition in rain. These ideas are then applied to estimation of the atmospheric inputs of trace metals and some anthropogenic organic substances to the North Sea. Atmospheric fluxes to the North Sea are

compared with inflows of the substances considered via rivers. Wet and dry deposition fluxes, as well as inputs from rivers, are given in tabular form. Analysis of these data of river inputs assume no addition or removal of pollutants as a result of processes within estuaries. It is clear that atmospheric inputs are dominant for Pb and for several synthetic organics, and not insignificant for almost all of the components listed (As, Cd, Cu, Cr, Ni, Hg, Zn, polycyclic aromates, pesticides, and polychlorinated biphenyls). (See also W89-02155) (Lantz-PTT)
W89-02168

TRANSFER OF TOXIC SUBSTANCES AT THE AIR/WATER INTERFACE: THE GREAT LAKES,
Wisconsin Univ.-Madison.
A. W. Andren.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 225-235, 7 tab, 17 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Air-water interface, *Great Lakes, *Lake Erie, *Lake Huron, *Lake Michigan, *Lake Superior, *Lake Ontario, Pollution, Aerosols, Precipitation, Polychlorinated biphenyls, Heavy metals, Cadmium, Chromium, Nickel, Zinc, Lead, Copper.

The atmosphere serves as an important transfer medium for a variety of microcontaminants in the Great Lakes region. Vapor-phase and aerosol associated contaminants are removed from the atmosphere both via wet and dry deposition. The mode of removal is very much dependent on the vapor pressure and aqueous solubility of the substance in question. The ratio of wet-to-dry removal for aerosol associated microcontaminants usually exceed 7:1 in the Great Lakes region. Substances that exist in both phases, such as PCBs, are also thought to be removed mainly with precipitation. However, vapor phase exchange in both directions are thought to occur and the magnitude of the process remains to be evaluated for all of the Great Lakes. For several trace metals the relative unit area loading intensity most likely is Erie > Ontario > Michigan > Huron > Superior. Loadings for Cd, Cr, Cu, Ni, Pb, and Zn range from about 0.002 to 1.0 kg/hr/yr. More than 90% of the Pb that presently deposits in Lake Michigan sediments comes in from the atmosphere. Most of this Pb is of anthropogenic origin. If Green Bay, Wisconsin is excluded from a mass balance of Lake Michigan, most of the PCBs that annually reach the lake also are atmospherically derived. A variety of other chlorinated hydrocarbons are also known to enter the lakes from the atmosphere. (See also W89-02155) (Lantz-PTT)
W89-02169

PCBS ON THE GLOBE: POSSIBLE TREND OF FUTURE LEVELS IN THE OPEN OCEAN ENVIRONMENT,
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
S. Tateya, S. Tanabe, and R. Tatsukawa.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 237-281, 14 fig, 8 tab, 51 ref.

Descriptors: *Polychlorinated biphenyls, *Seawater, *Marine environment, *Water pollution prevention, *Fate of pollutants, Prediction, Mathematical models, Model studies, Marine mammals, Tropical regions, Cold regions.

Results obtained when using non-steady state mathematical models, suggest that unless more than 50% of PCBs under use in the terrestrial environment are destroyed or confined to land itself, PCB concentrations in surface seawater will increase in tropical areas and remain at a constant level in temperate and colder areas. PCB concentrations in marine mammals will increase everywhere, but the time of attaining maximum concentration will be several decades after they have increased in the surface seawater. A similar situation is expected to occur with the other persistent chemicals. This model, with some modifications, seems to be applicable to large water bodies such as inland seas and lakes. (See also W89-02155) (Lantz-PTT)
W89-02170

DEGRADATION OF LAKE BAIKAL: FATE AND EFFECTS OF CONTAMINANTS PRESENT,
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
M. G. Henry, and A. M. Nikanarov.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 283-290, 1 fig, 1 tab, 17 ref.

Descriptors: *Water pollution sources, *Lake Baikal, *Legislation, *Water pollution control, *Pulp and paper industry, Water quality control, Wastewater treatment, Logging, Lakes, Waste disposal.

In 1957 a decision was made to bring industry to the shores of Lake Baikal. At the time, the focus of this industrialization was the manufacture of high grade cellulose cord for use in aircraft tire production. This product requires the use of ultra-pure water and the only available source was Lake Baikal. In addition, the watershed is rich in timber, electricity was already available and the Trans-Siberian railway was nearby. Construction of the Baikalsk Cellulose and Paper Combine (BCPC) began in 1959 despite almost immediate opposition from scientists, journalists and artists. Because of this outcry, planners added filtration equipment to the blueprints of the plant. This treatment facility was designed to use biological, mechanical and chemical purification techniques. Only Baikal's immense volume of water has ensured the slow rate of change in water quality, hardly aided by the treatment system. The Selenga Cellulose and Carton Combine (SCCC), built on the Selenga River, discharges into the Selenga River which ultimately reaches Lake Baikal. In 1971, a third law was passed to protect Lake Baikal. This law demanded that; (1) the BCPC treatment system be fully operational by the end of 1971; (2) the SCCC treatment facility be completed before opening; (3) all enterprises in the Lake Baikal basin were required to develop schedules for the addition of treatment facilities; (4) timber practices and shipping were to be improved - log flotation in the form of rafts was forbidden; and (5) in 1971-1975 already sunken logs were to be removed from rivers and portions of the lake. Indications are that even though some of these regulations have been implemented, deterioration of the lake is continuing. Suggestions have been made that the BCPCs waste discharges should be carried outside the boundaries of the Lake basin and then discharged. Additional suggestions have been put forth to demand closed-cycle operations of all plants, deposit SCCC wastes into deep strata below the earth's crust so that inputs into the Selenga River would cease, stop all rafting transport on the lake as well as on the tributaries, and develop improved gas/dust collectors for the stacks of all plants in the Lake Baikal region. (See also W89-02155) (Lantz-PTT)
W89-02171

CHEMICAL LIMNOLOGY OF PCBS IN LAKE SUPERIOR - A CASE STUDY,
Minnesota Univ., Minneapolis. Dept. of Civil and Mining Engineering.
S. J. Eisenreich, P. D. Capel, J. E. Baker, and B. B. Looney.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 291-318, 9 fig, 6 tab, 46 ref.

Descriptors: *Limnology, *Polychlorinated biphenyls, *Lake Superior, *Case studies, *Fate of pollutants, Water pollution sources, Organic compounds, Air pollution, Lake sediments, Mathematical studies, Organic carbon, Model studies, Ecological effects.

The aquatic behavior of polychlorinated biphenyls (PCBs) in Lake Superior gleaned from scientific studies over the last decade permits an evaluation of the chemical limnology and environmental fate of hydrophobic organic chemicals (HOC) having similar physical/chemical properties in large lakes. The range of properties (Henry's Law Constant K sub H, octanol-water partition coefficient K sub ow) describing the fate of the 50 to 100 PCB congeners observed in the environment suggest that air-water and sediment-water interactions dominate their aquatic behavior. PCBs likely enter the lake during intense periods of precipitation (scavenging of particles) and are subsequently lost during longer periods of volatilization. Although the atmosphere has served as a long term source of PCBs to the lake, decreasing inputs and water column concentrations suggest that the atmosphere is now a sink for PCBs previously deposited. Processes such as resuspension of bottom sediment and porewater containing PCBs dominate internal bottom sediment and porewater containing PCBs dominate internal cycling. Although only about 25% of the water-sorption PCBs occur in the particulate phase, sorption and subsequent removal of particles to the bottom is an important lake detoxification process. The observed inverse relationship of log K sub p and log suspended solids may be explained by mixed particle populations of differing organic carbon content and binding of PCBs to colloidal organic matter. The estimated residence time of PCBs in Lake Superior is a few years at most, and implies an efficient removal process. A dynamic mass balance model using a new PCB input function driven by atmospheric concentrations and considerations of air-water and sediment-water interactions adequately predicts observed water column concentrations. The Lake Superior ecosystem presently contains approximately 20,000 kg of PCBs about evenly divided between the sediment and water column reservoirs. (See also W89-02155) (Author's abstract)
W89-02172

CASE STUDY ON THE FATE OF HEAVY METALS: LAKE MAGGIORE, ITALY,
Commission of the European Communities, Ispra (Italy). Joint Research Centre.
H. Muntau, and R. Baudo.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 319-325, 4 fig, 5 tab.

Descriptors: *Path of pollutants, *Water pollution sources, *Heavy metals, *Lake Maggiore, *Italy, Tissue analysis, Fish, Bioaccumulation, Plankton, Cadmium, Mercury, Water sampling, Geochemistry, Sediment contamination, Lake sediments.

This chapter, which is an editorial inclusion to the volume, is comprised of graphics, with no written text. It was an editorial decision to include this limited information in the publication since the data represent a valuable reference. Tables and figures present: (1) the sampling plan for Lake Maggiore and catchment area; (2) sampling periods for Lake Maggiore and catchment area; (3) heavy metal forms, sources and outputs for Lake Maggiore and catchment area; (4) variations of heavy metal concentrations in net plankton and fish species (Lake Maggiore); (5) mercury and cadmium distributions in Lake Maggiore sediments; (6) comparison of heavy metal concentration ranges in Lake Maggiore and 330 European lakes; (7) anthropogenic and geochemical origin of heavy metals for Lake Maggiore; and (8) mercury and cadmium content in the major ecological compartments. (See also W89-02155) (Lantz-PTT)
W89-02173

CONTAMINANTS IN LAKE ONTARIO - A CASE STUDY,
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Regional Office.
R. L. Thomas, J. E. Gannon, J. H. Hartig, D. J. Williams, and D. M. Whittle.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contami-

nants. Lewis Publishers, Chelsea, Michigan, 1988. p 327-387, 15 fig, 12 tab, 97 ref.

Descriptors: *Lake Ontario, *Mercury, *Case studies, *Water pollution sources, *Path of pollutants, *Niagara River, Fish, Lead, Zinc, Copper, Polychlorinated biphenyls, Mirex, Pesticides, Lake sediments, Sediment contamination, Bioaccumulation, Volatilization, Path of pollutants.

Discovery of high mercury levels in fish during 1970 brought an awareness of toxic substances contamination in Lake Ontario. Sampling programs evolving from this initial finding resulted in the detection of high levels of PCBs and Mirex in 1976 and a definition of DDT and associated organochlorine pesticide distributions in the lake. Further amplification of the early findings, particularly between 1978 and present, has concentrated on refinement of analytical techniques, trend assessment, and analysis of contaminants throughout the aquatic ecosystem. This paper reviews the major contaminant issues of the lake and concentrates on defining major sources, loadings, and physical and ecological fate of Hg, Pb, Zn, Cu, PCBs and Mirex in the lake. In all cases the Niagara River is proven to be the major source with lake distribution responding to hydrodynamic processes. Each contaminant appears to be primarily associated with sediment and, other than PCBs, are accounted for in annual mass balances. Losses for PCBs are believed to be due to bioaccumulation and volatilization to the atmosphere. Concentrations of PCBs and Mirex in fish decreased between 1977 and 1981, but increased between 1981 and 1983-84 suggesting a reactivation of sources in the Niagara River. These sources are believed to be waste disposal sites adjacent to the river. This case study provides an important lesson on the susceptibility and consequences of toxic contamination to other large lakes of the world, and the critical need for source control on toxic substances and changeover to non-toxic processes, products and by-products. (See also W89-02155) (Author's abstract)
W89-02174

LAKE-WIDE IMPACTS OF LONG-TERM SOURCES OF XENOBIOTIC CONTAMINANTS: LAKE MANAGUA (NICARAGUA) AND LAKE MICHIGAN (UNITED STATES),
Amsterdam Univ. (Netherlands). Vakgroep Aquatische Oecologie.
For primary bibliographic entry see Field 5C.
W89-02175

POLLUTION HAZARDS OF AGRICULTURE,
Institute for European Environmental Policy, London (England).
D. Baldock.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 137-154, 1 fig, 2 tab, 12 ref.

Descriptors: *Agriculture, *Environmental effects, *Farm wastes, *Water pollution sources, *Nonpoint pollution sources, Erosion, Salinization, Silting, Drainage, Groundwater pollution, Fertilizers, Nitrogen, Phosphorus.

The nature and magnitude of the pollution hazards arising from farming vary enormously, reflecting both the differences in agricultural practice and the characteristics of the local environment. Some of the principal forms of pollution include soil erosion by water and wind, salinization arising from irrigation, increased silt load caused by land drainage, pollution of surface and groundwaters by inorganic fertilizers and livestock wastes, contamination of soils with heavy metals, multi-media pollution by pesticides and a number of other problems, such as water pollution from silage effluent and discarded pesticide containers. In most OECD countries, agriculture is responsible for a significant proportion of the nitrogen and phosphorus entering fresh waters is a major target for those concerned in the reduction of nonpoint sources of pollution. In the past, agriculture has escaped many of the regulatory pressures applied to industry and the control of nonpoint sources of pollution remains a relatively difficult challenge, although it may often be cost effective. In future, it seems likely that agriculture will be more susceptible to the dictates of the 'Polluter Pays' principle. Relatively restrictive legislation is now being introduced in some European countries where groundwater pollution has become a major concern. (See also W89-02176) (Lantz-PTT)
W89-02185

STRATEGIES FOR CONTROL OF NON-POINT SOURCE POLLUTION,
American Farmland Trust, Washington, DC.
For primary bibliographic entry see Field 5G.
W89-02186

RURAL GROUNDWATER CONTAMINATION.
For primary bibliographic entry see Field 2F.
W89-02196

NITRATES IN IOWA GROUNDWATER,
Iowa Dept. of Natural Resources, Iowa City.
G. R. Hallberg.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 23-68, 29 fig, 3 tab, 78 ref.

Descriptors: *Nonpoint pollution sources, *Nitrates, *Iowa, *Groundwater pollution, Water supply, Drinking water, Potable water, Water quality control, Agricultural chemicals, Wells, Waste disposal, Fertilizers, Agriculture, Public health.

During the past six years, studies in Iowa have generated considerable interest and concern with the occurrence and increasing concentrations of nitrate (NO3) in drinking-water supplies, particularly from groundwater. These studies have shown that nitrates and some pesticides are leaching through the soil into shallow groundwater and are now found in many of Iowa's groundwater aquifers. In many areas, these groundwater, which supply drinking water to both cities and private individuals, now commonly exhibit nitrate concentrations above the maximum contaminant limit (MCL) of public drinking water of 10 mg/L nitrate as nitrogen (45 mg/L as NO3). Trace amounts of many widely used pesticides have also been found in these aquifers in association with elevated nitrate concentrations. Well construction and poor waste disposal practices contribute to individual well problems, and spills and misuse of chemicals have caused more severe problems locally. However, the regional contamination of aquifers is the result of conventional usage of agricultural chemicals and constitutes a nonpoint source pollution problem. There are legitimate concerns for public health, over the long term, if these water quality problems continue or increase. While septic tanks, chemical spills, and poor well construction cause local problems, they are no longer a significant factor. Nitrate problems have become regional in scope, resulting from the widespread application of fertilizer. Grain production only accounts for about 50% of the nitrogen that can be managed. The intent of the on-going efforts in Iowa is to find the most effective ways to channel the fertilizer-N into grain production and minimize losses into water. This could also result in ways to use current amounts of fertilizer-N and improve yields. (See also W89-02196) (Lantz-PTT)
W89-02199

GROUNDWATER PROBLEM IN MICHIGAN: AN OVERVIEW,
Michigan State Univ., East Lansing. Inst. of Water Research.
For primary bibliographic entry see Field 2F.
W89-02200

LOSSES AND TRANSPORT OF NITROGEN FROM SOILS,
Iowa State Univ., Ames. Dept. of Agronomy.
A. M. Blackmer.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 85-103, 1 fig, 3 tab, 18 ref.

Descriptors: *Nonpoint pollution sources, *Nitrogen, *Path of pollutants, *Solute transport, *Nitrates, *Fertilizers, Soil chemistry, Nitrogen fixation, Leaching, Agriculture, Macropores, Soil porosity.

Use of fertilizer nitrogen has markedly increased over the past three decades and must be recognized as a major factor contributing to the abundance of food and fiber currently enjoyed by developed nations. The possibility that some portion of the fertilizer nitrogen applied to soils may leach into groundwater supplies has been recognized for as long as fertilizers have been used. However, concern about the importance of this problem is increasing. This chapter provides an overview of what is, and is not, known about processes that influence the amounts of nitrogen that escape from agricultural soils to groundwater. This objective is approached by: (i) briefly reviewing what happens to fertilizer nitrogen in soils; (ii) describing some of the difficulties associated with determination of the quantities of nitrogen lost from agricultural soils to groundwater; and (iii) summarizing results from some relevant studies in progress at Iowa State University, which indicate that nitrate moves through many Iowa soils by mechanisms that have not been recognized. The major difference is in the importance of preferential flow of water and nitrate though macropores (old root channels, worm holes, cracks, etc.) in the soil. The macropores act as 'super highways' that permit water and nitrate to bypass most of the soil within the rooting zone and move rapidly out of this zone. (See also W89-02196) (Lantz-PTT)
W89-02201

IMPACTS OF CHEMIGATION ON GROUNDWATER CONTAMINATION,
Science and Education Administration, Lincoln, NE
J. S. Schepers, and D. R. Hay.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 105-114, 1 tab, 19 ref.

Descriptors: *Nonpoint pollution sources, *Chemigation, *Groundwater pollution, *Fertilizers, *Path of pollutants, Nitrogen, Irrigation, Herbicides, Pesticides, Leaching, Siphons.

The earliest use of chemigation was for the application of fertilizer, primarily nitrogen, with the irrigation water to increase nitrogen-use efficiency. More recently, there has been increasing interest in and use of chemigation to apply herbicides, insecticides, fungicides and nematodes. Applying chemicals with an irrigation system usually accomplishes the intended application; however, water application rate and uniformity may not be compatible with time of application for maximum pesticide efficacy or fertilizer utilization. Unique to chemigation is the possibility of groundwater contamination due to accidental backflow or siphoning of chemicals down the well which is a form of point source pollution. The other type of groundwater contamination that can result from any method of chemical application (including chemigation) is the nonpoint leaching of chemicals through the soil and into the aquifer. Each mode of contamination can cause serious problems, but the processes involved are unique as are the remedial actions required after contamination. (See also W89-02196) (Lantz-PTT)
W89-02202

ASSESSING ANIMAL WASTE SYSTEMS IMPACTS ON GROUNDWATER: OCCURRENCES AND POTENTIAL PROBLEMS,
Soil Conservation Service, Washington, DC.
J. N. Krider.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 115-128, 2 fig, 16 ref.

Descriptors: *Water pollution sources, *Animal wastes, *Groundwater pollution, *Nonpoint pollution sources, *Waste management, Environmental

effects, Nitrogen, Bacteria, Fertilizers, Farm wastes, Livestock, Wastewater lagoons.

The health threat to humans and livestock from ingestion of water contaminated with animal waste should not be taken lightly. Nitrogen and bacterial organisms are the main constituents for which there should be concern. The potential for cancer in humans and in livestock from nitrates in water is an epidemiological area that needs study. However, case studies conducted in Delaware, Iowa, Pennsylvania, and California indicate that commercial fertilizers contribute more nitrogen to groundwater than does animal waste. But, this does not reduce the importance of proper management of manure nitrogen. Certain segments of animal waste management systems are responsible for most of the contribution of contaminants to groundwater. These are areas of high animal concentrations such as barnyards, locations of manure storage ponds and treatment lagoons, and sites of manure applications on agricultural land. Each separately, or in combination, can be responsible. (See also W89-02196) (Lantz-PTT)
W89-02203

GROUNDWATER CONTAMINATION FROM LANDFILLS, UNDERGROUND STORAGE TANKS, AND SEPTIC SYSTEMS,
Michigan Dept. of Natural Resources, Lansing. Groundwater Quality Div.
G. Klepper, G. Carpenter, and D. Gruben.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 147-159, 5 fig, 5 tab, 6 ref.

Descriptors: *Groundwater pollution, *Landfills, *Septic tanks, *Underground storage, *Michigan, Rural areas, Urban areas, Potable water, Water supply, Regulations, State jurisdiction, Federal jurisdiction, Drinking water.

Numerous contamination sites have been discovered in Michigan. Many of these have resulted in groundwater contamination, and a significant proportion have been found to result from landfills and underground storage tanks. More groundwater contamination incidents have occurred in rural areas rather than in urban areas. Rural areas appear to be at greater risk due to dependence on groundwater for potable water supplies and the tendency for private wells to be completed at shallower depths than municipal supply systems. Although larger in population, urban areas appear to be at less risk from contaminated groundwater. Current state and federal regulations and improved public and business awareness should help reduce the number of contamination sites in the future. Responsible party, State and Federal responses to known contamination incidents and prevention of future groundwater contamination are critical to protecting the nearly one-half of Michigan's population which depends on groundwater for its potable water. (See also W89-02196) (Lantz-PTT)
W89-02205

SOFTWARE FOR TEACHING PRINCIPLES OF CHEMICAL MOVEMENT IN SOIL,
Florida Univ., Gainesville. Dept. of Soil Science.
A. G. Hornsby.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 193-200, 3 fig, 1 tab, 4 ref.

Descriptors: *Path of pollutants, *Education, *Soil properties, *Groundwater movement, *Computer programs, Solute transport, Agricultural chemicals, CMIS, Chemical properties, Pesticides, Evapotranspiration, Precipitation, Root zone.

Farmers, county extension agents, state and federal action agency personnel, and the general public need to understand the behavior of chemicals in order to be responsible stewards of resources. To gain such an understanding, simple, uncomplicated methods are needed to provide insight into the processes which control movement of chemicals and to permit rational management decisions of pesticides use. A software package has been designed which can be used to understand the behavior of pesticides in soil better. Chemical Movement In Soil (CMIS) is a software package written to illustrate the influence of soil properties, chemical properties, plant rooting depth, precipitation, and evapotranspiration upon the movement and persistence of surface applied chemicals (pesticides) in well drained soils. This software is meant to serve as a teaching tool rather than a management tool since several assumptions were made to simplify the model and reduce data input requirements. The computational procedure assumes uniform soil properties and piston flow of water. (See also W89-02196) (Lantz-PTT)
W89-02208

FEASABILITY STUDY ON THE RETROSPECTIVE EVALUATION OF ANOMALOUS LOCAL TRITIUM FALLOUT BY THE ANALYSIS OF TREE RINGS FROM SELECTED DISTRICTS IN AUSTRIA AND HUNGARY,
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria).
D. Rank.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-702277. Price codes: A03 in paper copy, A01 in microfiche. Final Report for the Period: 1 June 1983 - 31 May 1986. Report No. IAEA-R-3452-F, January 1987. 34p, 6 fig, 8 tab, 23 ref.

Descriptors: *Dendrochronology, *Tritium, *Tree rings, *Path of pollutants, Hungary, Austria, Precipitation, Radioactive wastes, Radioisotopes, Water pollution sources.

A method for determining C-H found tritium (3-H) in the cellulose of tree rings was developed a few years ago in the Institute of Isotopes, Hungary. From the experience gained and from results thus far in hand, one can conclude that the tritium abundance recorded in tree rings is well related to the yearly average of tritium in precipitation and, in addition, indicates the superimposed contamination on a local scale. Since only limited information is available about considerable local 3-H contamination being measured, mostly around nuclear installations but sometimes far away from them, there is much room for speculation about the origin of the contamination. A sharp temporal rise in the 3-H level of precipitation was observed in a well-defined region of the Eastern Alps, Austria in May and June, 1984. Tritium concentration in the precipitation at the centre of the affected region reached a level of about 10 times higher than in other areas throughout Europe at the same time. This peak was also unusual compared with the results of other years before or after 1984. The objectives of the research project was to study the feasibility of tree ring analysis for short-term 3-H contamination. (Lantz-PTT)
W89-02263

SIMULATIONS OF WATER AND SOLUTE MOVEMENT IN THE BURIED WASTE REPOSITORY AT VAALPUTS,
Natal Univ., Pietermaritzburg (South Africa). Dept. of Soil Science and Agrometeorology.
J. L. Hutson.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-702239. Price codes: A02 in paper copy, A01 in microfiche. Report No. TRN:ZA8700123, January 1987. 16p, 4 fig, 4 tab, 8 ref.

Descriptors: *Underground waste disposal, *Radioactive waste disposal, *South Africa, *Path of pollutants, *Solute transport, *Vaalputs, Simulation analysis, Groundwater movement, Cesium, Model studies, Water level fluctuations, Computer models.

A series of simulations examined the movement of water through trench cap configurations of several types. The objective of this series is: (1) to extend the simulations from the surface to the bottom of the repository, accounting for the placement of drums; (2) to examine the magnitude and direction of water fluxes throughout this depth; and (3) to simulate the movement of solutes, using various assumptions regarding solute adsorption. Two models were used. The first was an adaptation of a solute transport model which incorporates the transient water flow model used in previous simulations. This was used primarily to estimate the likely water fluxes in the drum placement region. Since it requires large amounts of computer time this model was used to simulate periods of one or two years only. The second model was a very simple steady state solute transport model which was used to simulate Cs distribution after a 100 year periods, using flux data obtained from the transient model simulations. 'Worst case' situations were simulated. Some of these situations are unlikely in reality but provide a useful indication of the rates of movement of solute under various conditions. The most importance conclusion reached from this series of simulations is that the movement of Cs in the soil under the likely water regime is extremely slow. (Lantz-PTT)
W89-02264

5C. Effects Of Pollution

SEASONAL AND SPATIAL DISTRIBUTION OF IRON PRECIPITATING HETEROTROPHS IN WATER AND SEDIMENTS OF FISH PONDS OF DIFFERING FARMING MANAGEMENTS,
Kalyani Univ. (India). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W89-01271

EFFECTS OF OIL REFINERY EFFLUENTS ON SELENASTRUM CAPRICORNUTUM PRINTZ,
Udai Pratap Coll., Varanasi (India).Dept. of Botany.
J. P. Gaur, and H. D. Kumar.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 2, p 271-281, 1986. 7 fig, 3 tab, 14 ref.

Descriptors: *Oil wastes, *Oil refineries, *Algal growth, *Toxicity, *Bioassay, Phenols, Water quality, Effluents, Industrial wastes, Industrial wastewater, Wastewater disposal.

Laboratory-based bioassay experiments using Selenastrum capricornutum as the test organism were conducted to evaluate the potential of refinery effluents to sustain algal growth. The raw effluents were remarkably toxic to the test alga, but satisfactory algal growth occurred in (diluted) 0.01% effluents. The effluents from subsequent treatment stages required much less dilution to eliminate the toxicity. A highly significant negative correlation was found between the final yield of the test alga and the concentration of oil or phenol in the culture suspension. On the basis of these findings it is recommended that proper dilution of refinery effluents is necessary before they are discharged into any body of water. (Author's abstract)
W89-01272

STRUCTURE OF PERIPHYTIC COMMUNITIES IN COOLING POND OF NUCLEAR POWER PLANT,
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
For primary bibliographic entry see Field 2H.
W89-01273

EFFECTS OF EXPERIMENTAL ACIDIFICATION ON PHYTO-, BACTERIO- AND ZOOPLANKTON IN ENCLOSURES OF A HIGHLY HUMIC LAKE,
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
L. Arvola, K. Salonen, I. Bergstrom, A. Heinanen, and A. Ojala.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 6, p 737-758, 1986. 16 fig, 5 tab, 52 ref.

Descriptors: *Lakes, *Humic lakes, *Phytoplankton, *Zooplankton, *Bacteria, *Acid rain effects, *Acidic water, Acidification, Chlorophyll a, Primary productivity, Respiration, Acid rain, Enclosures, Hydrogen ion concentration.

In situ enclosure experiments were performed in a highly humic lake to examine the effects of acidification on phyto-, bacterio- and zooplankton. The acidity of three enclosures was adjusted with H2SO4 to pH 3.5, 4 and 5 and one enclosure and the lake served as controls. The diversity of plankton as well as the mean concentration of chlorophyll a, primary production and respiration of plankton decreased with increasing acidity. Bacterial density was slightly lower in the pH 3.5 enclosure than in the other enclosures and in the lake, but there were no differences in the morphological type or mean volume of the cells between different treatments. In the acidified enclosures Cryptomonas ovata and Chlamydomonas spp. were the dominant phytoplankters, while Dinobryon and Mallomonas species seemed to be the most sensitive to acidity. Keratella cochlearis, Kellicottia longispina and Bosmina longispina were the most tolerant zooplankton to acidity. (Author's abstract)
W89-01279

PHYTOPLANKTON BLOOM IN SHALLOW DIVOR RESERVOIR (PORTUGAL): THE IMPORTANCE OF INTERNAL NUTRIENT LOADING,
Instituto Nacional de Investigacao des Pescas, Lisbon (Portugal).
G. Cabecadas, M. J. Brogueira, and J. Windolf.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 6, p 795-806, 1986. 10 fig, 2 tab, 19 ref.

Descriptors: *Portugal, *Divor reservoirs, *Internal loading, *Phytoplankton, *Eutrophication, *Phosphates, Sediments, Turbidity, Iron, Nutrients, Suspended matter, Chlorophyll a.

The development of a heavy phytoplankton bloom (chlorophyll a=360 mg/cu m), which occurred in the summer 1983 in the shallow Divor Reservoir is described. The study shows that remobilization of phosphate from the sediment initiated the phytoplankton bloom. This was confirmed not only by calculations of the change in iron-phosphate pool, but also supported by sorption experiments carried out with the sediment. Turbidity of the water due to suspended matter caused the reduction in standing stock of phytoplankton to approximately 50 mg chlorophyll a/cu m in late summer. (Author's abstract)
W89-01282

GILL, LIVER, AND KIDNEY LESIONS ASSOCIATED WITH EXPERIMENTAL EXPOSURES TO CARBARYL AND DIMETHOATE IN THE FISH (PUNTIUS CONCHONIUS HAM.),
Kumaun Univ., Naini Tal (India). Dept. of Zoology.
T. S. Gill, J. C. Pant, and J. Pant.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 1, p 71-78, July 1988. 18 fig, 16 ref.

Descriptors: *Pesticides, *Water pollution effects, *Insecticides, *Pathology, *Pesticide toxicity, *Fish, *Carbaryl, Dimethoate, Kidneys, Gills, Liver, Animal tissues.

Carbaryl is a broad-spectrum insecticide used extensively in agriculture for foliar pests and for control of ectoparasites on livestock and pets; dimethoate has been recognized as an effective systemic and/or contact insecticide against a wide range of insects and mites. This report describes the cytopathology of branchial, hepatic and renal lesions in a common freshwater fish, Puntius conchonius, chronically exposed to these pesticides. With both, the pathological effects were most pronounced in the tubular epithelial cells which included hypertrophy, vacuolization, nuclear pycnosis, and disruption of the absorptive surface. In isolated cases, swollen Bowman's spaces and collapsed glomeruli were also encountered. The observed disorganization of tubular epithelial cells and glomeruli could be due to the damage to the cell's permeability barrier resulting in leakage of metabolites together with vital enzymes and coenzymes. Possibly, these events render the cells nonviable and autolysis manifests itself. Presently, however, a direct nephrotoxic action of the pesticides tested is difficult to demonstrate in this species. Perhaps the pesticide-induced damage to the gills overburdens the kidneys with the task of water and electrolyte homeostasis. (Sans-PTT)
W89-01298

HEAVY METAL EFFECTS ON CELLULAR SHAPE CHANGES, CLEAVAGE, AND LARVAL DEVELOPMENT OF THE MARINE GASTROPOD MOLLUSK (ILYANASSA OBSOLETA SAY),
Mount Desert Island Biological Lab., Salsbury Cove, ME.
G. W. Conrad.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 1, p 79-85, July 1988. 1 fig, 1 tab, 12 ref. Marine and Freshwater Biomedical Sciences Specialized Center of Research Grant EHS 1 P30 ESO3828, NIH HD07193 and NASA NAGW-1197.

Descriptors: *Water pollution effects, *Heavy metals, *Toxicity, *Gastropods, *Ilyanassa, *Embryonic development, *Pollutants, Embryonic growth stage, Larval growth stage, Mercury, Copper, Zinc, Cadmium, Lead, Chromium, Silver.

Polar-lobe formation, associated with microfilaments, is seen in the fertilized eggs of many marine mollusks. This study investigated the effects of Ag, Hg, Cu, Zn, Cd, Pb, and Cr on the embryonic development of the marine snail Ilyanassa obsoleta. The results suggest that several heavy metals affect the microfilament-dependent developmental steps. Cu may induce the early appearance of a microfilament band and induce its precocious constriction. Ag may cause the microfilament band of late Phase II polar lobe necks to remain organized and constricting, rather than depolymerizing, thereby cleaving the neck. Cr may cause the microfilament band of late Phase II polar lobe necks to become stabilized in structure and stop constricting. Microtubule involvement is not suggested in the effects of Cu, Ag, and Cr on these early cellular shape changes. (Sand-PTT)
W89-01299

EFFECT OF PETROLEUM AROMATIC HYDROCARBONS ON MONOGENEIDS PARASITIZING ATLANTIC COD, GADUS MORHUA L.,
Memorial Univ. of Newfoundland, St. John's. Dept. of Biology.
R. A. Khan, and J. W. Kiceniuk.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 1, p 94-100, July 1988. 4 fig, 16 ref.

Descriptors: *Water pollution effects, *Oil pollution, *Toxicity, *Hydrocarbons, *Fish parasites, *Cod, Pollutants, Trematobes, Platyhelminthes.

This study investigated whether a relationship exists between gill lesions and gill parasites in cod following chronic exposure to petroleum hydrocarbons. Fish were exposed 10-14 weeks to 3 hydrocarbon concentrations (30, 80 and 500 ppb). Two groups were held for an additional 16-20 weeks following exposure. The severity of gill lesions was correlated with the level of hydrocarbon concentrations. These lesions included epithelial hyperplasia, capillary dilation and lamellae fusion. Excessive numbers of mucus-secreting cells were also observed in all treated fish. The prevalence and intensity of monogenean parasites were greater in cod following chronic exposure (12-13 weeks) to low concentrations of hydrocarbons only after they were retained for an additional 16-20 weeks. Since there was no difference between oil-treated and control fish immediately following the exposure period, additional infestation presumably occurred during the period of depuration. The toxic components in the water-soluble oil fraction which induced branchial irritation resulting in epithelial and mucus-cell hyperplasia probably provided a habitat conducive for parasitic infestation and reproduction. (Sand-PTT)
W89-01300

EUTROPHICATION OF THE COASTAL WATERS OF THE NORTH ADRIATIC SEA: NATIONAL AND REGIONAL INTERVENTION PROGRAMS,
Emilia-Romagna Regional Authorities, Bologna (Italy).
G. Nespoli.
Annals of the New York Academy of Sciences ANYAA9, Vol. 534, p 946-949, 1988.

Descriptors: *Adriatic Sea, *Italy, *Water pollution control, *Eutrophication, *Coastal waters, *Wastewater treatment, *Environmental protection, Phosphorus, Irrigation water, Wastewater reclamation, Legislation, Water treatment.

During the 1970's, eutrophication became a problem in many coastal areas of Italy, particularly along the Emilia-Romagna coast. An international meeting in 1977 became the basis for a comprehensive structured multidisciplinary research program aimed at setting down how eutrophication could be contained and reduced. Attention was focused on phosphorus, not because it is the sole cause of eutrophication, but because measures to curb phosphorus input are both technically and economically feasible. The Emilia-Romagna Regional Plan provides for measures to curb the largest phosphorus sources. The aim is to reduce the trophic load discharged by the Po and other rivers into the region so as to achieve at least mesotrophic conditions off the Adriatic coast. The Region is in the final stages of plans for urban waste treatment plants, with the priority being a network of coastal treatment plants where nutrient abatement is to be achieved by recycling waste water to irrigation. In order to control animal waste, a set of norms was issued to govern both the discharge of liquid waste into water courses as well as its use on agricultural land as fertilizer. New laws have been established which control the maximum phosphorus content in household detergents and washing powders. To ensure that these norms are observed, the Region has started a watchdog campaign involving health officers and people working in other sectors such as fisheries, hunting, water management and voluntary workers. (Sand-PTT)
W89-01304

EUTROPHICATION OF INLAND AND COASTAL WATERS IN ITALY,
Istituto di Ricerca sulle Acque, Milan (Italy). Reparto Sperimentale di Idrobiologia Applicata.
R. Marchetti, A. Provini, and G. F. Gaggino.
Annals of the New York Academy of Sciences ANYAA9, Vol. 534, p 950-958, 1988. 4 fig, 3 tab, 12 ref.

Descriptors: *Eutrophication, *Coastal waters, *Lakes, *Eutrophic lakes, *Water pollution control, Italy, *Wastewater treatment, Phosphorus removal, Nitrogen removal, Adriatic Sea.

In Italy, the problem of water eutrophication concerns the whole national territory, including both lake and coastal waters. The existence of a period during the year when the role of nitrogen is prevailing raises doubts about the strategy, pursued for a long time, with the aim of phosphorus loading reduction. In such a period a reduction of nitrogen loading would also be needed. However, interventions concerning nitrogen removal involve a series of difficulties: (1) Sewage treatment for nitrogen removal is performed in anaerobic plants needing substantial modifications of the existing structures and, ultimately, a further delay in recovery policies. Phosphorus removal does not entail this sort of problem; (2) The management of a nitrogen removal plant is much more difficult than that for phosphorus, due to the greater complexity of the biological processes involved in nitrogen removal compared to the chemical processes of phosphorus removal; (3) The cost for nitrogen removal is much higher than for phosphorus removal, because of the additional investments needed for the construction of treatment plants; (4) There is much greater uncertainty about the results on nitrogen as compared with phosphorus removal, due to its prevailing non-point origin. With these difficulties in mind, strategies concerning the control and reduction of phosphorus and nitrogen loading are discussed. (Sand-PTT)
W89-01305

EUTROPHICATION IN THE EMILIA-ROMAGNA COASTAL WATERS IN 1984-1985,
Emilia-Romagna Regional Authorities, Bologna (Italy).
A. Rinaldi, and G. Montanari.
Annals of the New York Academy of Sciences ANYAA9, Vol. 534, p 959-977, 1988. 29 fig, 1 tab.

Descriptors: *Eutrophication, *Coastal waters, *Adriatic Sea, *Italy, Water pollution sources, Nutrients.

Eutrophication conditions in the northwest Adriatic Sea are conditioned primarily by material delivered by rivers (the Po and other coastal rivers). The summer/autumn blooms do the most harm since they can generate, apart from organoleptic alterations in the water, conditions of oxygen deficiency in the bottom water with resulting die-offs of benthonic organisms. In 1984 an exceptional bloom of the dinoflagellate Gymnodinium occurred, involving vast zones with notable levels of temperature and salinity. 1985 was also exceptional in that the summer season was not affected by eutrophication conditions which had involved the Emilia-Romagna coast for about a decade. This situation can be attributed to the lack of rain and the resulting reduction in the amount of river water from the Po and other local rivers. This situation confirms the determining role of the flow of river water to the sea, and underlines a number of other important aspects that should not be ignored. One of these is tied to the role of sediment, which does not seem capable of making a sufficient contribution to the process of triggering and nourishing algal bloom. Another aspect is tied to the material emptied into the sea along the coast, not in the sense of hydrographic basins for the various rivers, but rather from the viewpoint of the civilian installations along the coast. It would appear that these, despite the population growth during the summer months, are not capable of causing significant eutrophication conditions in coastal waters. This would support the hypothesis that no meaningful responsibility for the cause of eutrophication can be attributed to the discharge from water treatment facilities. (Sand-PTT)
W89-01306

EFFECTS OF CHEMICAL POLLUTANTS AND PHYTOPLANKTON BLOOMS ON THE MARINE BIOLOGICAL RESOURCES OF THE ADRIATIC SEA,
Bologna Univ. (Italy). Ist. di Biochimica.
R. Viviani.
Annals of the New York Academy of Sciences ANYAA9, Vol. 534, p 986-999, 1988. 7 fig, 2 tab, 53 ref.

Descriptors: *Italy, *Coastal waters, *Water pollution effects, *Eutrophication, *Adriatic Sea, *Heavy metals, Polychlorinated biphenyls, Chlorinated hydrocarbons, Fish, Shellfish, Fate of pollutants, Mercury, Lead, Cadmium, BHC, DDT, Halogenated pesticides, Insecticides, Diatoms, Dinoflagellates, Bioaccumulation, Detoxification, Pollutants, Toxicity, Phytoplankton.

Studies are reported concerning the content of toxic metals (Hg, Pb, Cd) and chlorinated hydrocarbons (BHC, DDT, polychlorinated biphenyls) in shellfish and fish of the North and Middle Adriatic Sea, their concentration in the different trophic chains, the detoxication mechanism in marine animals, and the evaluation of residues of pollutants in fish products consumed by humans. As far as the phytoplankton bloom in the coastal area facing Emilia-Romagna is concerned, the types of diatoms and dinoflagellates and the special identification of potentially toxic dinoflagellate species were identified. Effects of anoxia resulting from the blooms on marine organisms were studied and methods to determine possible biotoxins produced by dinoflagellates likely to have effects on marine organisms and on man were investigated. (Author's abstract)
W89-01307

PHYSICO-CHEMICAL, BACTERIOLOGICAL, AND BIOLOGICAL STUDY OF THE GENEVAN ALLONDON RIVER BASIN (ETUDE PHYSICO-CHIMIQUE, BACTERIOLOGIQUE ET BIOLOGIQUE DE L'ALLONDON GENEVOISE),
Institut d'Hygiene, Geneva (Switzerland).
M. Dethier, R. Revaclier, and A. Wisard.
Archives des Sciences, Geneve ASGVAH, Vol. 38, No. 2, p 109-129, May-August 1985. 3 fig, 6 tab, 9 ref. English summary.

Descriptors: *Switzerland, *Stream bioata, *Water pollution effects, *Water pollution sources, *Rivers, *Bacterial analysis, *Water quality, Physicochemical properties, Allondon River, Fauna.

The Swiss part of the Allondon river basin is a relatively small portion of the entire drainage-basin of the river but represents one of the most interesting natural sites of the canton of Geneva. The physico-chemical, bacteriological and biological analysis clearly show that the condition of the river is going bad. Some small tributaries are still in good condition and could be reservoirs of fauna for the main river if they are rapidly protected. (Author's abstract)
W89-01314

ORIGIN AND INFLUENCE OF COAL MINE DRAINAGE ON STREAMS OF THE UNITED STATES,
Geological Survey, Richmond, VA.
For primary bibliographic entry see Field 5B.
W89-01315

DISSOLVED OXYGEN DYNAMICS IN THE MID-PASSAIC RIVER: LATE SUMMER/EARLY FALL 1983-4 FIELD STUDIES,
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
C. G. Uchrin, W. K. Ahlert, A. P. Cryan, J. V. Giga, and S. F. Hsueh.
Journal of Environmental Science and Health (A) JESEDU, Vol. 23, No. 6, p 525-542, 1988. 14 fig, 2 tab, 6 ref.

Descriptors: *Water pollution effects, *Water quality, *New Jersey, *Passaic River, *Dissolved oxygen, Photosynthesis, Chlorophyll a, Respiration, Algae.

Field studies were conducted on the Passaic River in northeast New Jersey. Factors investigated included diurnal dissolved oxygen, photosynthesis and respiration, and chlorophyll a. A correlation was developed for diurnal dissolved oxygen variation as a function of chlorophyll a concentration. Both chlorophyll a and dissolved oxygen varied as a sinusoidal function of time with maxims and minima occurring at roughly the same times. (Author's abstract)
W89-01324

CHALLENGE OF ACID RAIN,
State Univ. of New York at Albany. Atmospheric Sciences Research Center.
V. A. Mohnen.
Scientific American SCAMAC, Vol. 259, No. 2, p 30-38, August 1988.

Descriptors: *Acid rain, *Air pollution effects, *Environmental effects, *Path of pollutants, *Environmental protection, *Power plants, Reviews, Environmental policy, Coal gasification, Fluidized beds, Water pollution sources, Sulfur oxides, Nitrogen oxides.

The alarm over the increasing acidity of precipitation in Europe and eastern North America was first sounded in the 1960's. Since then the most attention has been focused on acid rain's effects, established and suspected, on lakes and streams, with their populations of aquatic life, and on forests, although the list of concerns is far broader. The study of the effects, chemistry, and control of acid rain has grown into a major scientific enterprise in the past twenty years. Sulfur dioxides (SO_2) and oxides on nitrogen emitted into the atmosphere are chemically converted into forms that are readily incorporated into cloud droplets: sulfuric and nitric acids. The acid rain may fall hundreds of miles from the pollution source. Wherever it lands, it undergoes a new round of physical and chemical alterations, which can reduce the acidity and change the chemical characteristics of the water that eventually reaches lakes and streams. Certain scientists have speculated that to protect lakes and streams in sensitive areas such as the Adirondacks, it will be necessary to reduce acid deposition to less than 50 percent of its current level. Guidance for determining where and by how much emissions will have to be reduced will come from two massive computer models of acid production, transport and deposition that are now being tested. Ultimately, the greatest emission reductions promise to be from the repowering of aging plants using clean-buring technology (e.g., fluidized-bed combusion, gasification/combined cycle). This would affect the full range of pollutants implicated in acid rain. The strategy could cut sulfur dioxide emissions by more than 80 percent and nitrogen oxide emissions by more than 50 percent. (Vernooy-PTT)
W89-01380

TRICHLOROETHYLENE: WATER CONTAMINATION AND HEALTH RISK ASSESSMENT,
California Dept. of Health Services, Berkeley. Hazard Evaluation Section.
For primary bibliographic entry see Field 5B.
W89-01385

EFFECT OF ENDOSULFAN ON ADENOSINE TRIPHOSPHATASE (ATPASE) ACTIVITY IN LIVER, KIDNEY, AND MUSCLES OF CHANNA GACHUA,
Jiwaji Univ., Gwalior (India). School of Studies in Botany.
R. M. Sharma.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 317-323, September 1988. 4 tab, 13 ref.

Descriptors: *Endosulfan, *Channa gachua, *Insecticides, *Fish, *Pesticide toxicity, *Sublethal effects, Enzymes, Toxicity, Adenosine triphosphatase, Water pollution effects, Biochemical tests.

Large scale application of pesticides to agricultural and forest areas may contribute to the presence of these toxic substances in the environment. Among these different kinds, that of organochlorines require special attention because of the high stability and toxicity these compounds display with regard to aquatic flora and fauna. Toxicity of these compounds to aquatic organisms is a hundred times greater than that of organophosphorus compounds. The present study was undertaken to determine the effect of an organochlorine insecticide, Endosulfan (6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydrc-6,9-methano-2,4,3-benzo dioxathiepin-3-oxide) on the activity of adenosine triphosphatase (ATPase) in liver, kidney and muscles of a freshwater teleost, Channa gachua. The inhibition of ATPase activity was in the order of liver > muscles > kidney. Maximum inhibition of ATPase was observed in liver Na(+), K(+) ATPase at 0.0056 and 0.0037 mg/L concentration after 15 and 30 days exposure, respectively. Na(+), K(+) ATPase shows higher sensitivity to Endosulfan than Mg(++) ATPase in the present study. (VerNooy-PTT)
W89-01388

IN VITRO EFFECT OF MERCURY AND CADMIUM ON BRAIN CA(++)-ATPASE OF THE CATFISH ICTALURUS PUNCTATUS,
Mississippi Univ. Medical Center, Jackson. Dept. of Neurology.
R. S. Reddy, R. R. Jinna, J. E. Uzodinma, and D. Desaiah.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 324-328, September 1988. 1 tab, 15 ref.

Descriptors: *Water pollution effects, *Adenosine triphosphatase, *Toxicity, *Catfish, *Mercury, *Cadmium, *Fish, Biochemical tests, Brain, Heavy metals, Tissue analysis.

Although heavy metals have been shown to affect Na(+)-K(+)-ATPase in the brain and Ca(++)-

ATPase in the gills of fish, the mode of action of heavy metals on fish brain Ca(++)-ATPase has not been clearly understood to date. This study evaluated the in vitro effect of divalent metals, mercury and cadmium on Ca(++)-ATPase in the brain of catfish, Ictalurus punctatus. Brain tissue from channel catfish was exposed to mercuric and cadmium chloride solutions. Both the divalent cations inhibited the Ca(++)-ATPase activity in the brain. Inhibition of enzyme activity by mercury was observed at concentrations as low as 0.1 micro M, while a similar effect by cadmium was recorded at 1 micro M. The 50% enzyme inhibition level of mercury obtained through dose-response curves was 3.8 micro M, while that of cadmium was 22.0 micro M. The present work confirms the presence of Ca(++)-activated ATPase in the brain of freshwater catfish. It could be conceived that the two divalent cations may alter cellular configuration by interfering with Ca(++)-sites on Ca(++)-ATPase. (VerNooy-PTT)
W89-01389

MERCURIAL INDUCED CHANGES IN THE HYPOTHALAMO-NEUROHYPOPHYSICAL COMPLEX IN RELATION TO REPRODUCTION IN THE TELEOSTEAN FISH, CHANNA PUNCTATUS (BLOCH),

Banaras Hindu Univ., Varanasi (India). Centre of Advanced Study in Zoology.
R. M. Ram, and K. P. Joy.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 329-336, September 1988. 6 fig, 27 ref.

Descriptors: *Mercury, *Channa punctatus, *Fish, *Toxicity, *Sublethal effects, *Water pollution effects, Biochemistry, Gonads, Heavy metals, Fungicides, Emisan, Enzymes.

Inorganic mercuric chloride (HgCl2) and organic mercurial fungicide (Emisan) induced changes in the hypothalamo-neurohypophysical system in relation to reproduction of C. punctatus are described after chronic exposure for 6 months. Three groups each of 50 adult fish, weighing 45-55 g and 12-16 cm in length were used. Fish in group I and II were exposed to 'safe concentrations' of either 0.01 ppm of inorganic mercuric chloride (HgCl2) or 0.20 ppm of an organic mercurial fungicide, Emisan. The untreated group III served as the control. The experiment was started when the gonads were in immature stage-I condition, and terminated after a continuous exposure for 6 months when the gonads in the control group were fully matured. In fish of both experimental groups, the neurons exhibited various degrees of degeneration. Corresponding with nuclear changes in the neurons, the brain MAO (monoamine oxidase) activity was also significantly inhibited in both treated groups. The ovaries from both experimental groups were in immature stage-I condition, and in the testis of treated fish sperms were lacking and the Leydig (interstitial) cells were inactive and atrophied. Changes in the gonadotrophs of the pituitary were also observed. Both mercurials induced reduction of MAO, which is an indirect evidence of impairment of the monoaminergic system responsible for modulating the hypophysiotrophic control of gonadotropic function. On the basis of these results, it can be inferred that mercurials-induced inhibition of the gonadal growth might have been mediated through the impairment of the hypothalamo-neurohypophysial-gonadal axis, in this species. (VerNooy-PTT)
W89-01390

CHANGES IN NITROGEN METABOLISM OF PENAEID PRAWN, PENAEUS INDICUS, DURING SUBLETHAL PHOSPHAMIDON AND METHYLPARATHION-INDUCED STRESS,

Sri Venkateswara Univ., Tirupati (India). Dept. of Marine Zoology.
M. S. Reddy, K. V. R. Rao, and B. N. Murthy.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 344-351, September 1988. 3 tab, 21 ref.

Descriptors: *Pesticides, *Shrimp, *Biotransformation, *Insecticides, *Toxicity, Sublethal effects, Phosphothioate pesticides, Organophosphorus pesticides, Lethal limits, Crustaceans, Metabolism, Bioassay.

Certain aspects of ammonia production and its utilization in the selected tissues of penaeid prawn, Penaeus indicus exposed to sublethal concentrations of phosphamidon (PE) or methylparathion (ME) organophosphorus insecticides were studied. P. indicus is considered to be a sensitive indicator of marine and estuarine pollution and also is important in the fishery industry in India. LC50 values in static bioassay tests were found to be 0.9 ppm for phosphamidon and 0.095 ppm for methylparathion to the intermolt prawn for a 48 h exposure. In a 72 h, aerated exposure to 0.3 ppm phosphamidon or 0.03 ppm methylparathion, midgut gland, muscle and gill tissues were used for biochemical analysis. An increment in the AMP deaminase and adenosine deaminase activity levels indicated the augmented purine catabolism resulting in an elevation of ammonia content. To avert the toxicity of ammonia, the tissues have mobilized this toxic metabolite into the synthesis of comparatively safer substances like urea and glutamine as evidence through the increased specific activities of arginase and glutamine synthase respectively. All these metabolic changes were more pronounced in ME prawn tissues when compared to PE prawn tissues. (VerNooy-PTT)
W89-01391

EFFECT OF AN ANIONIC DETERGENT ON THE LIPID MOIETIES OF VARIOUS CELL TYPES IN THE OPERCULAR EPIDERMIS OF RITA RITA,

Banaras Hindu Univ., Varanasi (India). Dept. of Zoology.
D. Roy.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 352-359, September 1988. 2 tab, 9 ref.

Descriptors: *Water pollution effects, *Fish, *Surfactants, *Detergents, *Histology, Lethal limits, Sublethal effects, Epidermis, Lipids, Tissue analysis, Histochemistry, Bioaccumulation, Operculum.

The histochemical change caused by an anionic detergent, dodecylbenzene sodium sulfonate in the various lipid moieties of different cell types in the opercular epidermis at different exposure times. Fish (Rita rita) were exposed to 6.9 mg/L (the 96-hr LC50) of the detergent. At frequent intervals, fish were sacrificed and their opercula were dissected and histochemically examined. With Sudan black B, with and without prior treatment of various extraction techniques, the epithelial cells throughout the opercular epidermis indicate the presence of moderate amounts of lipids. Transferring the fish into the detergent medium for three or more days causes disappearance of most of the lipid moieties from the epithelial cells as evidenced by negative reactions with most of the lipid staining techniques. Decreases in various lipid moieties were also seen in the goblet mucous cells and club cells under the influence of the detergent treatment. The effect of the detergent treatment on the mucous membrane is instant as evidenced by immediate profuse secretion by the cells of the epidermis. This mucous coat is, however, neither sufficient nor permanent, but synthesis and secretion of mucus is a continuous process. Although the question of skin permeability to water is complex and the structure of the epidermis is probably more important from this point of view than the chemistry of the secretions, the lipid in the skin surface secretions may provide a barrier between the internal and the external environment of the fish, acting as a water repellent and limiting the entry of water into the body of these species. (VerNooy-PTT)
W89-01392

ACUTE TOXICITY OF CYANOGEN CHLORIDE TO DAPHNIA MAGNA,

Minnesota Univ., St. Paul. Dept. of Fisheries and Wildlife.
D. W. Kononen.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 371-377, September 1988. 3 tab, 11 ref.

Descriptors: *Toxicity, *Cyanogen chloride, *Cyanide, *Daphnia, *Bioassay, *Lethal limit, Crustaceans, Median tolerance limit, Water pollution effects.

The destruction of cyanide in waste waters by chlorination has been shown to result in the formation of the extremely toxic compound, cyanogen chloride (CNCl). The half-life values of CNCl have been determined to range from 1 min at 45 C to 10 h at 5 C. Toxic concentrations of this compound may, therefore, be present in a given waste receiving water for a period of time sufficient to result in acute toxicity to populations of aquatic organisms. In this study the acute toxicity of CNCl to Daphnia magna neonates under static bioassay conditions was examined. With daphnid neonates up to 5 days old, the 24-h and 48-h LC50s were 86 micrograms/L and 65 micrograms/L, respectively. Using neonates $<$ or $=$ 24 hours old, the LC50 values were 40 micrograms/L and 29 micrograms/L. Strictly speaking, the LC50 values derived from this study do not pertain to pure CNCl since this compound undergoes considerable hydrolysis at alkaline pH. The observed lethality could be attributed to a combined effect of CNCl and its hydrolysis by-products (i.e., Cl(-), NH3, CO2, etc.). (VerNooy-PTT)
W89-01393

COMBINED TOXICITY OF COPPER, CADMIUM, ZINC, LEAD, NICKEL, AND CHROME TO THE COPEPOD TISBE HOLOTHURIAE,

Athens Univ. (Greece). Zoological Lab. and Museum.
G. Verriopoulos, and S. Dimas.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 378-384, September 1988. 3 fig, 1 tab, 16 ref.

Descriptors: *Heavy metals, *Synergistic effects, *Toxicity, *Copepods, *Lethal limit, Copper, Lead, Cadmium, Zinc, Nickel, Chrome, Water pollution effects, Bioassay.

In this study the acute toxicity of six heavy metals (Cu, Cd, Zn, Pb, Ni and Cr) to the marine copepod Tisbe holothuriae Humes was determined. Ovigerous females of Tisbe, a common Mediterranean benthic copepod, were used. The 48-hr LC50s were as follows: Cu = 0.37 mg/L; Zn = 0.62 mg/L; Cd = 0.91 mg/L; Ni = 2.58 mg/L; Pb = 6.34 mg/L; Cr = 14.13 mg/L. Combinations of two metals were also tested, with solutions containing varying percentages of the 48-hr LC50s of the metals. In all experiments, clear cases of synergism were observed. The order of the toxicity of the various combinations of toxicant mixtures is the following: Pb+Cr = Cd+Zn $<$ Ni+Cr $<$ Zn+Ni $<$ Pb+Zn = Ni+Cu = Zn+Cu = Cd+Cr $<$ Cd+Ni $<$ Cd+Cu $<$ Pb+Ni $<$ Zn+Cr $<$ Pb+Cu $<$ Cr+Cu = Pb+Cd (based on the toxicity of a solution containing 50% of the LC50 of each toxicant). (Vernooy-PTT)
W89-01394

DIFFERENTIAL COURTSHIP ACTIVITY AND ALTERATIONS OF REPRODUCTIVE SUCCESS OF COMPETING GUPPY MALES (POECILIA RETICULATA PETERS; PISCES: POECILIIDAE) AS AN INDICATOR FOR LOW CONCENTRATIONS OF AQUATIC POLLUTANTS,

Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W89-01395

TOXICITY OF POTASH BRINES TO EARLY DEVELOPMENTAL STAGES OF ATLANTIC SALMON (SALMO SALAR),

Department of Fisheries and Oceans, St. Andrews (New Brunswick). Biological Station.
R. H. Peterson, D. J. Martin-Robichaud, and J. Power.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 391-397, September 1988. 1 fig, 2 tab, 12 ref.

Descriptors: *Mine wastes, *Brines, *Potash, *Salmon, *Toxicity, *Lethal limits, Mortality, Embryonic growth stage, Immature growth stage, Stream pollution, Water pollution effects, Bioassay, New Brunswick, Canada, Potassium, Fish, Salinity, Seasonal variation.

Concentrated brines of potash solutes are used as part of the process of mining potash in southeastern New Brunswick. These brines consist primarily of the chlorides of potassium, sodium and calcium. Pipeline ruptures have resulted in spills of concentrated brine and dead fish were observed for a distance of 1.5 km downstream of the spill site. The toxicity of this brine was tested on various aspects of early salmonid (Salmo salar) development to determine whether fish mortality could be attributed to the spill. Of the stages tested, newly feeding fry were most sensitive to potash brine, with a 7-d LC50 of a brine dilution corresponding to a conductivity of 3600 microsigmas (K(+) concentration of 16 mM). Newly hatched alevins were less sensitive than fry with a 7-d LC50 at a K(+) concentration of 48.2 mM (conductivity of 10,740 microsigmas). The toxicity of the brine solution to salmon alevins could be accounted for by the K(+) present in it, since the 7-d LC50 for pure KCl solutions was 49.4 mM. Eyed eggs were more tolerant of potash brine than either fry of alevins with a 7-d LC50 at 92-118 mM K(+) (20,500-26,300 microsigmas). Early cell divisions of newly fertilized salmon eggs are also extremely sensitive to potash solution, with growth of the blastodiscs being slowed at the lowest dilution tested (1.8 mM K(+)), and mortality occurring at 90 mM. The impact of hypersaline potash spills obviously is dependent upon the life stages of salmon in the impacted stream at the time of the spill. Fortunately, the documented spills occurred in mid-winter, and eggs at that time should have been fairly tolerant (7-d LC50 ca. 10,000 microsigmas). (VerNooy-PTT)
W89-01396

CHANGES IN FOOD (CHLORELLA) LEVELS AND THE ACUTE TOXICITY OF CADMIUM TO DAPHNIA CARINATA (DAPHNIDAE) AND ECHINISCA TRISERIALIS (MARCOTHRICIDAE) (CRUSTACEA: CLADOCERA),
Delhi Univ. (India). Dept. of Zoology.
T. Chandin.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 398-403, September 1988. 2 fig, 1 tab, 16 ref.

Descriptors: *Cadmium, *Toxicity, *Daphnia, *Crustaceans, Bioassay, Diets, Lethal limits, Stress, Water pollution effects, Heavy metals, Food habits.

The present study was initiated to determine the acute effects of cadmium on two cladoceran species - Daphnia carinata and Echinisca triserialis commonly found in freshwater of Delhi. Daphnia adults are 2.5-2.9 mm and Echinisca adults are 0.7-0.9 mm. The two species were chosen to determine the magnitude of toxicity in relation to body size, and if differences of food levels could modify the acute toxicity effects on these cladocerans. The 48-h and 96-h LC50's for E. triserialis were 345 and 70 micrograms/L at low food levels, 370 and 58 micrograms/L at medium food levels and 460 and 340 micrograms/L at high food levels. For D. carinata the values were 265 and 110 micrograms/L at low food levels, and 350 and 235 micrograms/L at medium food levels. A 48-h LC50 was not obtained by D. carinata at a high food level, but at 96-h, a LC50 was achieved at a 480 micrograms/L cadmium. The LC50 values of E. triserialis were lower than those of D. carinata at all the three food levels tested, and the survival of both species was greatly affected by food stress. It is concluded that factors such as availability of food in the natural waters may severely affect pollutants such as cadmium in either enhancing it or mitigating it. (VerNooy-PTT)
W89-01397

SUBLETHAL TOXICITY AND ACCUMULATION OF CADMIUM IN TILAPIA AUREA,
Agricultural Coll. of Athens (Greece). Dept. of Applied Hydrobiology.
S. E. Papoutsoglou, and P. D. Abel.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 3, p 404-411, September 1988. 2 fig, 3 tab, 14 ref.

Descriptors: *Cadmium, *Bioaccumulation, *Tilapia, *Toxicity, *Sublethal effects, Water pollution effects, Fish, Mortality, Heavy metals, Tissue analysis, Aquaculture.

Tilapia species are important food fishes in many countries and are increasingly important in aquaculture, yet relatively little information exists on their susceptibility to many pollutants. The present paper reports an investigation into the sublethal toxicity of cadmium in Tilapia aurea. Groups of 150 juvenile T. aurea were exposed to a mean concentration of 1.5, 6.8, 14, 28, or 52 micrograms/L cadmium for 16 weeks. Mortalities among test fish were low and not related to cadmium concentration. Cadmium also appeared to have no effect on the growth, or on the moisture, fat, protein or ash content or hemoglobin concentration of the fish. Of the variables measured, only the hematocrit value after 10 weeks exposure and the muscle cadmium concentrations indicate the effects of cadmium. A preliminary estimate of the maximum acceptable cadmium concentration for Tilapia would be between 14 and 30 micrograms/L. Although the suggested figure for Tilapia is based partially on tissue cadmium levels rather than solely on criteria of toxicity to the fish itself, in view of its importance as a food fish this approach is considered justifiable. (VerNooy-PTT)
W89-01398

DETERMINATION OF LEAD IN TREATED CRAYFISH PROCAMBARUS CLARKII: ACCUMULATION IN DIFFERENT TISSUES,
Valencia Univ. (Spain). Dept. of Analytical Chemistry.
For primary bibliographic entry see Field 5B.
W89-01399

SEASONAL AND SPATIAL VARIABILITY IN MACROBENTHOS COMMUNITIES IN JAMAICA BAY, NEW YORK: AN URBAN ESTUARY,
Brooklyn Coll., NY. Dept. of Biology.
D. R. Franz, and W. H. Harris.
Estuaries ESTUDO, Vol. 11, No. 1, p 15-28, March 1988. 10 fig, 4 tab, 29 ref, 1 append. National Park Service Contract CX1600-1-0031.

Descriptors: *Water pollution effects, *New York, *Estuaries, *Benthos, *Macroinvertebrates, Trace metals, Toxicity, Species diversity, Population density, Sediments, Organic carbon, Seasonal variation, Spatial distribution, Statistical analysis.

Macrobenthos were sampled at 27 sites on a seasonal basis from October 1981 through November 1982. Cluster analyses and principal components analyses indicated that although spatial and species groupings were weak, an underlying sediment-correlated structure persisted for all seasons. Weak station groupings resulted from great seasonal and local variability in abundance of several dominant taxa. The most widely distributed species varied the least in density over time. Species richness and dominance were uncorrelated. Dominance was correlate with sediment organic content (percent total organic carbon) and percent mud. Species richness increased with increasing percent total organic carbon, reaching a maximum in the range 0.7 to 1.0% total organic carbon (primarily sand stations). At higher organic levels (muddy sand stations), species richness was inversely correlated with percent total organic carbon and heavy metals concentrations. In both sand and mud communities, species richness was positively correlated with density. This study indicates that environmental factors associated with percent total organic carbon exert a negative effect both on species richness and density above a threshold of about 1.25%, and that toxic metals may be a significant factor in causing this decline. (Author's abstract)
W89-01424

EFFECTS OF FLUORIDE CONCENTRATION IN SEAWATER ON GROWTH AND FLUORIDE ACCUMULATION BY SYDNEY ROCK OYSTER (SACCOSTREA COMMERCIALIS) AND FLAT OYSTER (OSTREA ANGASI) SPAT,
New South Wales Dept. of Agriculture, Sydney (Australia). Div. of Fisheries.
J. A. Nell, and G. Livanos.
Water Research WATRAG, Vol. 22, No. 6, p 749-753, June 1988. 1 fig, 4 tab, 17 ref.

Descriptors: *Bioaccumulation, *Fluorides, *Water pollution effects, Shellfish, Smelter wastes, *Oysters, Seawater, Growth, Mortality, Salinity, Temperature, Spat, Tissue analysis, Public health.

Fluoride concentrations in Sydney rock oyster spat increased linearly from 45 to 204 microgram (ug)/g dry spat with increasing seawater fluoride additions from 0 to 30 mg/l. Over this fluoride range, weight gains decreased linearly with a 20% growth depression at the highest concentration. Higher concentrations of fluoride were found in spat of both species held at a salinity of 15 ppt in 30 mg F/l than in those held at salinities of 25, 35, and 45 ppt at the same seawater fluoride concentration. Spat of both species grew fastest at salinities of 25 and 35 ppt. Mortalities of flat rock oyster spat were higher at 15 ppt than at salinities of 25, 35, and 45 ppt. Weight gains for Sydney rock oysters increased with increasing temperatures from 12 to 30 C. Fluoride concentrations in Sydney rock oyster spat held in seawater containing 50 mg F/l at 24 and 30 C (2282 and 2130 ug/g dry spat) were much higher than those held at 12 and 18 C (1116 and 1140 ug/g dry spat). (Author's abstract)
W89-01452

DISSOLVED OXYGEN IN STREAMS AND RESERVOIRS,
Tennessee Valley Authority, Chattanooga.
For primary bibliographic entry see Field 5G.
W89-01498

THERMAL EFFECTS,
South Carolina Public Service Authority, Moncks Corner.
M. E. Harrelson, J. Hudson, and J. B. Cravens.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 978-983, June 1988. 38 ref.

Descriptors: *Literature review, *Thermal pollution, *Temperature effects, *Water pollution effects, *Aquatic habitats, Primary productivity, *Ecosystems, Consumers, Food chains, Macrophytes, Algae, Fish, Shellfish, Crustaceans, Respiration, Thermal stress, Mortality, Model studies.

Literature published in 1987 on thermal effects in aquatic environments is summarized under the following headings: reviews and models, producers (aquatic plants), consumers (larvae and embryonic), feeding, growth, habitat, oxygen metabolism, mortality, thermal tolerance, temperature preference, temperature and other stresses, and biochemical reaction studies. Algae and macrophytes are discussed as producers; fish, shellfish, and crustaceans are discussed as consumers. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01500

EFFECTS OF POLLUTION ON FRESHWATER ORGANISMS,
American Scientific International, Duluth, MN.
A. Pilli, D. O. Carle, E. Kline, Q. Pickering, and J. Lazorchak.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 994-1065, June 1988. 3 tab, 648 ref.

Descriptors: *Literature review, *Water pollution effects, *Bioassay, *Natural waters, *Data collec-

tions, Mortality, Animal behavior, Biological magnification, Organic compounds, Heavy metals, Pesticides, Acids, Detergents, Effluents, Chlorinated hydrocarbons, Polychlorinated biphenyls, Sediments, Surfactants, Environmental Protection Agency, AQUIRE Data Base, Population exposure.

Literature published in 1987 on effects of pollution on freshwater organisms is summarized in tables. Pollutant effects (lethality, growth effects, behavioral effects, bioconcentration, and other effects) are listed for various pesticides, organic chemicals, heavy metals, acids, detergents, effluents, chlorinated hydrocarbons, polychlorinated biphenyls, sediments, and surfactants. Data were extracted from the EPA's Aquatic Information Retrieval (AQUIRE) data base. For each pollutant, the organism tested and the concentration, its effect, the duration of the effect, and the literature citation for the data are given. (Rochester-PTT)
W89-01502

EFFECTS ON SALTWATER ORGANISMS,
California State Univ., Long Beach. Dept. of Biology.
D. J. Reish, P. S. Oshida, A. J. Mearns, and T. C. Ginn.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 1065-1077, June 1988. 1 tab, 170 ref.

Descriptors: *Literature review, *Seawater, *Water pollution effects, *Fate of pollutants, *Data collections, Tissue analysis, Heavy metals, Pesticides, Hydrocarbons, Chlorinated hydrocarbons, Nutrients, Trace elements, Oil spills, Industrial wastes, Plants, Invertebrates, Fish, Mammals, Mortality, Morbidity, Reproduction, Ocean dumping, Toxicity, Environmental effects, Population exposure.

Literature published in 1987 on effects of water pollution on marine organisms (plants, invertebrates, fish, and mammals) is summarized under the following headings: residues and related topics, surveys (after oil spills), diseases, reproductive damage, impacts of ocean debris and fishing gear, ecological events, and toxicity. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. In addition, a table is included summarizing reports of chemical residues in marine organisms, including concentration in tissue, locality, and literature citation for the report. Chemicals listed are Al, As, Ba, Cd, Ca, Ce, Cr, Co, Cu, Fe, La, Pb, Li, Mg, Mn, Hg, Mo, Ni, Nb, K, Na, Sc, Se, Ag, Sr, Tl, Th, Sn, U, V, Y, Zn, Zr, chlordane, DDE, DDT, dieldrin, hexachlorobenzene, hexachlorohexane, hydrocarbons, kepone, mirex, polychlorinated biphenyls, photomirex, octochlorostyrene, and organotin. (Rochester-PTT)
W89-01503

SUBSTRATE ASSOCIATED MICROBIOTA,
Pennsylvania State Univ., University Park. School of Forest Resources.
N. J. Bowers, and J. R. Pratt.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 1088-1093, June 1988. 73 ref.

Descriptors: *Literature review, *Sampling, *Ecology, *Substrates, *Water pollution effects, *Microbiological studies, Periphyton, Adenosine triphosphate, Respiration, Biomass, Bacteria, Food habits, Flagellates, Light, Diatoms, Colonization, Microenvironment, Species composition, Adaptation, Aquatic habitats.

Literature published in 1987 on substrate-associated microorganisms in relation to water pollution control is summarized, including methodology and ecology. Topics include sampling periphyton, field extraction of ATP, in situ respiration measurement, biomass and production of bacteria, preferential grazing of bacteria by microflagellates, light adaptation of diatoms, colonization of sand grains by diatoms, diatom community structure, and adaptations to microenvironment. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01505

EFFECTS OF CHEMICALS ON MICROORGANISMS,
Environmental Protection Agency, Washington, DC. Office of Toxic Substances.
J. D. Walker.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 1106-1121, June 1988. 3 tab, 67 ref.

Descriptors: *Water pollution effects, *Literature review, *Microbiological studies, *Bioassay, *Water analysis, *Data collections, *Toxicity, Enzymes, Metabolism, Fungi, Yeasts, Bacteria, Performance evaluation, Bacterial physiology, Comparison studies, Microtox test, Algae, Structure-activity relationships, Chlorinated hydrocarbons, Pesticides, Dyes, Hydrocarbons, Inorganic compounds, Heavy metals, Toxins, Phenols, Quinones, Daphnia, Invertebrates, Fish, Sludge microorganisms.

Literature published in 1987 on effects of chemicals on microorganisms is summarized under the following headings: bacterial toxicity tests (bioluminescence, microcalorimetry, enzyme activity, tetrazolium dye reduction, oxygen uptake, methanogenesis, and adenosine triphosphate); algal toxicity tests; fungal and yeast toxicity tests; comparative sensitivity of microbial toxicity testing systems; comparative sensitivity of microbial, terrestrial, and aquatic organisms testing systems; quantitative structure-activity relationships; and use of microbes to assess toxicity in different environments (water, sediment, wastewater, and soil). A table is included showing the effective concentrations in mg/l obtained with microbial tests (mainly Microtox) done with chlorinated hydrocarbons, aliphatic and aromatic hydrocarbons, pesticides, dyes, inorganic compounds, heavy metal salts, and other compounds. Comparative toxicity of phenols and quinones with Beneckea harveyi and of hydroquinone and hydroquinone with B. harveyi and Daphnia pulex also are considered. Results also are presented showing comparative toxicities of organic compounds to activated sludge microorganisms, invertebrates, fish, and Chlorella vulgaris. (Rochester-PTT)
W89-01507

INFLUENCE OF INDICATOR BACTERIA ON THE INCIDENCE OF SALMONELLA IN AQUATIC ENVIRONMENT,
Hiroshima Univ. (Japan). Faculty of Applied Biological Science.
For primary bibliographic entry see Field 5A.
W89-01510

RECENT DEVELOPMENTS IN THE LAW OF THE SEA 1986,
For primary bibliographic entry see Field 6E.
W89-01518

ILLNESS AND RESERVOIRS ASSOCIATED WITH GIARDIA LAMBLIA INFECTION IN RURAL EGYPT: THE CASE AGAINST TREATMENT IN DEVELOPING WORLD ENVIRONMENTS OF HIGH ENDEMICITY,
Texas Univ. Medical School at Houston. Program in Infectious Diseases and Clinical Microbiology.
P. S. Sullivan, H. L. DuPont, R. R. Arafat, S. A. Thornton, and B. J. Selwyn.
American Journal of Epidemiology AJEPAS, Vol. 127, No. 6, p 1272-1281, June 1988. 5 tab, 15 ref.

Descriptors: *Giardia lamblia, *Diarrhea, *Human disease, *Epidemiology, *Giardiasis, *Path of pollutants, *Water pollution effects, *Parasites, *Drinking water, *Contamination, Infection, Public health, Children, Developing countries, Economic aspects, Parasites, Nile River, Deltas, Egypt.

A longitudinal investigation of the health effects and reservoirs of Giardia was undertaken during 1984-1985 in 40 households located in the rural Nile delta region of Egypt. Stool specimens obtained once weekly for six months from 2-4 year-old children were cyst- or trophozite-positive in 42% of the 724 examined. Only one child remained Giardia-negative during the study. The mean duration of excretion in Giardia-positive children was seven and one-half weeks with a range of one to 17 weeks. Mucus was present in 52% of all stools collected, and fecal leukocytes were observed with surprising frequency in absence of identifiable pathogens. Clinical symptoms of illness were frequently observed within a month before or after Giardia excretion in stool of children, but a statistical inference of association was not demonstrated. Seventeen percent of 697 specimens obtained from their mothers were Giardia-positive for a mean duration of four weeks and a range of one to 18 weeks. A total of 962 specimens was collected from 13 species of household livestock. Giardia was detected in 22 specimens from cows, goats, sheep, and one duck. Giardia cysts were detected in three of 899 samples of household drinking water. The ubiquity of the protozoan as well as the failure to show an association between infection and symptomatic illness argue against the administration of Giardia-specific drugs to children in settings where the risk of reinfection is high and for whom intestinal insults are both varied and constant. (Author's abstract)
W89-01525

TWO DECADES OF SUCCESSFUL HAZARDOUS WASTE DISPOSAL WELL OPERATION: A COMPILATION OF CASE HISTORIES,
Davis (Ken E.) Associates, Houston, TX.
For primary bibliographic entry see Field 5E.
W89-01577

USE OF DETRENDED CORRESPONDENCE ANALYSIS IN EVALUATING FACTORS CONTROLLING SPECIES COMPOSITION OF PERIPHYTON,
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-01607

SAMPLING AND INTERPRETATION OF ALGAL PATTERNS FOR WATER QUALITY ASSESSMENTS,
Louisville Univ., KY. Dept. of Biology.
For primary bibliographic entry see Field 7C.
W89-01608

GROUND WATER CONTAMINATION BY ORGANIC CHEMICALS: UNCERTAINTIES IN ASSESSING IMPACT,
California Univ., Los Angeles. School of Public Health.
For primary bibliographic entry see Field 5B.
W89-01667

EFFECTS OF PESTICIDE APPLICATIONS ON FORESTED WATERSHEDS,
Florida Univ., Gainesville. School of Forest Resources and Conservation.
D. G. Neary.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 325-337, 10 fig.

Descriptors: *Water pollution effects, *Pesticides, *Forest watersheds, Methoxychlor, Picloram, Hexazinone, Trees, Insecticides, Herbicides.

Insecticides have been applied to regulate outbreaks of terrestrial insects and to study instream detritus processing dynamics of aquatic insects. Some of the original research on the effects of

forest treatments on water yield used herbicides to simulate cutting or induce vegetation succession. The water quality impacts of pesticide applications to Southern Appalachian forests were investigated in some of these studies. More recently, a series of projects have conducted research to determine the impact of site preparation herbicides on water quality. With increased use of herbicides and insecticides in modern forest management, and the rising sensitivity of the public to the fate of pesticides in the environment, these studies have become more important. One study reported upon in this chapter used methoxychlor to exclude macroinvertebrates from a small first-order watershed adjacent to watershed 10 (WS 10). The methoxychlor (24% emulsifiable concentrate) was introduced into the stream source areas at a rate of 5 g/cu m, based on stream discharge in February 1980. Supplemental applications of 10 g/cu m were conducted in May, August, and November. During the period of the study concentrations of methoxychlor in streamflow never exceeded 33 mg/cu m. Despite these low concentrations, some drastic impacts on the invertebrate population occurred. Another study involved the effect of both picloram and hexazinone on woody plants. Both herbicides proved to be effective on the range of tree species in the oak-hickory forest ecosystem. Hexazinone is a unique herbicide in that most pines are tolerant of herbicide rates which kill hardwoods. Some species such as red maple and black gum show slight resistance to both herbicides. The effects of drought in reducing the activity of both herbicides were noted. Although the herbicides produced shifts in vegetation structure from forest to grass-broadleaf herbaceous plant system, they were not investigated in any detail. (See also W89-01691) (Lantz-PTT)
W89-01708

ACID PRECIPITATION EFFECTS ON FOREST PROCESSES,
Georgia Univ., Athens. Dept. of Botany.
B. L. Haines, and W. T. Swank.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 359-366, 2 fig, 3 tab.

Descriptors: *Acid rain, *Water pollution effects, *Forests, Sulfates, Nitrates, Plants, Hydrogen ion concentration, Pine trees.

Plant biomass accumulation and reproductive investment integrate both above and below ground plant-environmental interactions. Essential interactions include: (1) the net acquisition of solar radiation at rates avoiding increased respiration or damage to leaves by overheating; (2) the net acquisition of CO2 through stomata to the mesophyll of leaves with minimum loss of water by the reverse pathway; (3) the net acquisition of essential mineral elements while avoiding accumulation of some elements at toxic concentrations; and (4) the net acquisition of water from soil in excess of water loss rates via transpiration. Acid rain is but one of many potentially interacting factors which can influence the net acquisition of energy, CO2, minerals, and water. Experimental work suggests that the threshold for damage to some ecosystem processes is between pH 2.0 to 3.0, while acid rain at Coweeta ranges from 3.1 to 6.4 with a volume weighted average of 4.6. If rainfall acidity were to increase from the lowest recorded 3.1 by a factor of four to 2.5, measurable change would probably occur. Potential negative effects of gaseous air pollutants are more immediate. The SO4 and NO3 in acid rain are generally thought to be derived from SOx and NOx liberated to the atmosphere in the burning of fossil fields. Although the volume weighted rainfall pH at Coweeta of 4.68 is more than 100 times higher than the threshold for leaf damage, the authors have postulated that the ambient concentrations of SOx, NOx, and/or O3 at Coweeta may be high enough to have direct effects on net plant metabolism. The threshold for acid rain damage to white pine at Coweeta is about pH 1.5 and during the summer period, pH of bulk precipitation was not abnormally low. (See also W89-01691) (Lantz-PTT)
W89-01710

TRACE METALS IN THE ATMOSPHERE, FOREST FLOOR, SOIL, AND VEGETATION,
Emory Univ., Atlanta, GA. Dept. of Biology.
H. L. Ragsdale, and C. W. Berish.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 367-380, 3 fig, 6 tab.

Descriptors: *Water pollution effects, *Trace metals, *Forest watersheds, Soil contamination, Toxicity, Soil columns, Copper, Zinc, Lead, Cadmium, Heavy metals, Vegetation, Fate of pollutants.

Trace metals can have detrimental effects in the ambient environment at low levels, while high levels of trace metals can be lethal. The absence of a trace element data base at Coweeta coupled with the realization that trace elements may be exceedingly important in the growth and health of ecological systems were the primary reason for initiating this study. The soil column (O1 + O2, A, and upper B horizon) of two, low-elevation control watersheds in the Coweeta Basin contains lower concentrations of trace elements (Cu, Zn, Pb, and Cd) than commonly reported for many other North American sites. The litter-humus forest floor burdens of Cu, Pb, and Zn were 20 times smaller than found in forests of the industrialized northeastern United States. The largest trace element burden in the forest floor was for Zn. The low standing stocks of trace metals in low-elevation forest floors at Coweeta indicate that present atmospheric inputs of metals are low. Lead concentrations in Carya boles at low elevations have increased both in historical and recent times. Historical increases in Pb may have been related to regionwide disturbance from metal smelting. Recent increases in trace metal concentrations are the result of smaller annual growth rings. Since the early 1900s, trace metal burdens in hickory wood has remained constant. Lead concentrations in the high elevation Albert Mountain litter and humus samples were significantly greater than those at the lower elevations of watersheds 2 and 18. The greater Pb concentrations at high elevation result from long range transport and deposition of airborne Pb particles. Similar trace metal deposition patterns have been found for high-elevation sites in the northeast. (See also W89-01691) (Lantz-PTT)
W89-01711

ECOLOGICAL EFFECTS OF IN SITU SEDIMENT CONTAMINANTS.
Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr W. Junk Publishers, Boston, 1987. 272p. Edited by R. Thomas, R. Evans, A. Hamilton, M. Munawar, T. Reynoldson, and H. Sadar.

Descriptors: *Ecological effects, *Water pollution effects, *Contamination, *Sediments, Trace metals, Organic compounds, Adsorption, Particle size, Toxicity.

The interaction between land and water is characterized by the transfer of terrestrial material derived from weathering and erosion into the aquatic system. Sediment is transported, sorted and deposited according to its textual properties and to the physical characteristics of the transporting medium. Fine-grain sediments separated from their coarser counterparts during transport are deposited in areas of either restricted circulation or in deeper waters where the physical processes necessary to induce resuspension and further transport are lacking. These finer sediments are well known for their ability to adsorb both trace metals and relatively insoluble organic compounds. In natural systems, the adsorption process generally proceeds in a manner that results in the removal of those naturally occurring elements and compounds considered toxic to aquatic organisms at high concentrations. Life itself has adapted to these conditions and it is no accident that elements of high solubility are non-toxic to biological systems. The balances contained in natural systems are altered by the increased uptake of toxic materials introduced into watercourses through human activities. The resulting increase in sediment concentrations of toxic contaminants, which are the manifestation of increased natural substances such as heavy metals, is the definition of in situ contaminants. (See W89-01714 thru W89-01735) (Lantz-PTT)
W89-01714

INTERACTIONS BETWEEN SEDIMENT CONTAMINANTS AND BENTHIC ORGANISMS,
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Regional Office.
For primary bibliographic entry see Field 5B.
W89-01719

SEDIMENT-ASSOCIATED CONTAMINANTS AND LIVER DISEASES IN BOTTOM-DWELLING FISH,
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
D. C. Malins, B. B. McCain, D. W. Brown, U. Varanasi, and M. M. Krahn.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 67-74, 2 fig, 2 tab, 27 ref.

Descriptors: *Sediment contamination, *Liver, *Fish diseases, *Water pollution effects, *Toxicity, Statistical studies, Organic compounds, Hydrocarbons, Chlorinated hydrocarbons, Benthic environment, Bile, Chemical analysis, Puget Sound, Washington, Path of pollutants.

High concentrations of chemicals have been found in sediments from urban areas of Puget Sound. Hundreds of organic chemicals (including certain aromatic hydrocarbons (AHs) and various chlorinated compounds) were identified. Statistical methods were used to evaluate possible relationships between the chemistry data and fish diseases. Positive correlations were found between the frequencies of liver neoplasms (e.g., hepatocellular carcinoma) and other liver lesions in English sole (Parophrys vetulus) and concentrations of AHs in sediment; such correlations were not found with chlorinated hydrocarbons. Strong evidence was also obtained to show that many organic chemicals in sediment are bioavailable to bottom-dwelling fish. Stomach contents (consisting mainly of benthic invertebrates) from English sole had concentrations of a number of AHs similar to those in the sediment from which the fish were taken. In these same fish, metabolites of many aromatic compounds were found in bile using a procedure combining HPLC with fluorescence detection. Further, the concentrations of certain xenobiotic metabolites in bile were correlated positively with the occurrence of liver neoplasms in English sole. (See also W89-01714) (Author's abstract)
W89-01720

PHYTOPLANKTON BIOASSAYS FOR EVALUATING TOXICITY OF IN SITU SEDIMENT CONTAMINANTS,
Canada Centre for Inland Waters, Burlington (Ontario).
M. Munawar, and I. F. Munawar.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 87-105, 12 fig, 4 tab, 41 ref.

Descriptors: *Water pollution effects, *Toxicity, *Phytoplankton, *Bioassay, *In situ tests, Algae, Biological studies, Computers, Great Lakes, Ecological effects.

Routine bulk chemical characterization of sediments does not provide useful information on toxicity of sediment bound contaminants. This study reviewed and evaluated the utility of phytoplankton bioassays for evaluation of toxicity of sediment bound contaminants, including state-of-the-art techniques. Several techniques such as Algal Fractionation Bioassays, microcomputer-based toxicity testing and in situ bioassays including plankton cages have been developed and successfully applied in research at various contaminated sites in

the St. Lawrence Great Lakes. These bioassay techniques are sensitive, rapid and inexpensive for screening contaminant. The use and application of such techniques, based on bioavailability and physiological response of microorganisms, are essential for the detection of environmental perturbations of an ecosystem. Such an early warning system will facilitate the preservation and rehabilitation of the Great Lakes. (See also W89-01714) (Author's abstract)
W89-01723

IN SITU CONTAMINANTS AND ENVIRONMENTAL ASSESSMENT: AN ECOLOGICAL SUMMARY,
FEARO, Halifax (Nova Scotia).
G. E. Beanlands.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 113-118, 1 fig, 16 ref.

Descriptors: *Environmental impact statement, *Ecology, *Ecological effects, *Water pollution effects, Environmental effects, History, Decision making, Prediction, Biological studies.

The origins of the concept of environmental impact assessment (EIA) are outlined to explain why the scientific basis has not developed as well as the procedural aspects. The question is raised of the role of ecological science in environmental impact assessment and the compatibility of the objectives of the ecologist with those of the decision makers is discussed. A conceptual framework for the consideration of the problems of in situ contaminants is presented within the context of environmental assessment. One of the major constraints on the application of ecological science to EIA is the limit of current knowledge. Ecology is a a relatively young science. As such it lacks the well developed theoretical base common to more mature sciences such as physics, chemistry and biology. One of the results is that the predictive capability of ecological science is very limited, a serious limitation with respect to its useful application in assessment. Some of the main reasons for, and implications of, this limited predictive capacity are: natural variability, reference to managed ecosystems, and the focus on populations. (See also W89-01714) (Lantz-PTT)
W89-01725

CONTAMINATED SEDIMENTS IN THE ELBE ESTUARY: ECOLOGICAL AND ECONOMIC PROBLEMS FOR THE PORT OF HAMBURG,
Behoerde fuer Wirtschaft, Verkehr und Landwirtschaft, Hamburg (Germany, F.R.).
L. Tent.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 189-199, 7 fig, 3 tab, 52 ref.

Descriptors: *Water pollution effects, *Elbe River, *Estuary, *Sediment contamination, Hamburg, Wastewater disposal, Oxygen, Harbors, Dredging, Water pollution sources, Economic aspects, West Germany.

The lower Elbe is polluted by poorly treated domestic sewage and industrial effluent. This has led to a major change on the oxygen content of the water and to the presence of contaminated sediment. The Port of Hamburg is situated in the limnic region of the Elbe estuary in West Germany. The areas for cargo handling and storage, industrial and merchant firms, harbor basins and the river Elbe cover 87 sq km (12% of the Hamburg state territory). In the lower Elbe and in many waterways within the harbor, water depths (about 13 m) are maintained by dredging. The resulting 2.5-million cu m of dredged material are disposed on land by hydraulic transport. With increasing knowledge about sediment contamination, problems have arisen regarding further disposal. Intensive investigations have been conducted concerning alternative solutions, waste water treatment, safety for groundwater, gasification, metal extraction and possibilities for agricultural use. Techniques have been developed for the controlled disposal of dredged material in hill-shaped deposits. (See also W89-01714) (Author's abstract)
W89-01731

CONSEQUENCES OF ENVIRONMENTAL CONTAMINATION BY LEAD MINING IN WALES,
Bradford Univ. (England). School of Environmental Science.
For primary bibliographic entry see Field 5B.
W89-01733

PREDICTING THE EFFECTS OF A POSSIBLE TEMPERATURE INCREASE DUE TO STREAM REGULATION ON THE EGGS OF WHITEFISH (COREGONUS LAV ARETUS) - A LABORATORY APPROACH,
Oslo Univ. (Norway). Zoological Museum.
S. J. Saltveit, and A. Brabrand.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 219-228, 8 fig, 3 tab, 9 ref.

Descriptors: *Water pollution effects, *Regulated flow, *Thermal pollution, *Streams, Water temperature, Whitefish, Norway, Ecological effects, Seasonal variation, Eggs.

In the fjord lake Randsfjorden, Norway, the whitefish (Coregonus lavaretus) has four sympatric populations. One of these spawns in the lower parts of the main inlet River Dokka-Etna, while the others spawn in the lake. In this region, with very low winter temperatures, most egg development takes place in the autumn and spring. Regulation plans for the inlet river and its catchment will lead to changes in discharge and autumnal temperature increase below the power station, since water will be taken from a deep release reservoir and subsequently released to the river as minimum instream flow. Reduced water flow and increased temperature during autumn and winter are expected to affect life history parameters of the river spawning whitefish, including migration, spawning time, available spawning area, egg development and hatching time. The present studies agree with experiments that have shown that less degree days are required by fish eggs for embryonic development at lower water temperatures. Two major independent processes in embryonic development and hatching have been distinguished. After exposure to low temperatures a thermal cue seems necessary to induce hatching rather than cumulative degree days. Therefore river regulation giving rise to increased temperatures during winter and an earlier temperature increase in spring, will probably have a more pronounced effect than an autumnal increase. Preliminary results also indicate a mechanical effect of suspended material, producing earlier hatching compared to unexposed eggs. This seems to be most important when hatching occurs at temperatures (below 5 C). Further studies are now being carried out on egg development at low temperatures and the factors which induce hatching. (See also W89-01736) (Lantz-PTT)
W89-01750

COMPARISON OF FIELD AND LABORATORY BIOACCUMULATION OF ORGANIC AND INORGANIC CONTAMINANTS FROM BLACK ROCK HARBOR DREDGED MATERIAL,
Environmental Research Lab., Narragansett, RI.
J. L. Lake, W. Galloway, G. Hoffman, W. Nelson, and K. J. Scott.
Available from the National Technical Information Service, Springfield, VA. 22161 as AD-A197 118. Price codes: A10 in paper copy; A01 in microfiche. Technical Report No. D-87-6, May 1988. Final Report. 194p, 53 fig, 236 tab, 38 ref, 3 append.

Descriptors: *Bioaccumulation, *Inorganic compounds, *Black Rock Harbor, *Dredging, *Water pollution effects, *Path of pollutants, *Organic compounds, Tissue analysis, Biological studies, Polychlorinated biphenyls, Aromatic compounds, Hydrocarbons, Bivalves, Bioassay, Polychaetes, Connecticut, Comparison studies.

The utility of laboratory tests for predicting bioaccumulation of contaminants in the field was evaluated by comparing the identities, relative abundances, and quantities of organic and inorganic contaminants accumulated by organisms exposed to dredged material in both laboratory and field studies. The organisms used were Mytilus edulis (a filter-feeding bivalve) and Nephtys incisa (a benthic polychaete). These organisms were exposed in the laboratory and in the field to a contaminated dredged material from Black Rock Harbor (BRH), Connecticut. Similar pattern (relative abundances of constituents within a sample) and concentration changes for polychlorinated biphenyls (PCBs), and concentration changes for some polycyclic aromatic hydrocarbons (PAHs) and the pesticide ethylan, were observed in residues from M. edulis exposed to BRH material in the laboratory or from field exposure to BRH material at stations near the disposal site. The similarity of these changes indicated a relationship between the laboratory and field bioaccumulations for M. edulis. Relationships were found in the patterns and concentrations of PCBs and PAHs in residues in N. incisa exposed in the laboratory and in the field. No relationships between laboratory and field exposures could be found for metals accumulated in N. incisa. The laboratory-to-field relationships found in this study demonstrate that properly designed laboratory exposure tests have utility for predicting the identities and patterns of PCB and PAH contaminants accumulated in some field-exposed organisms. (Lantz-PTT)
W89-01773

PERSISTENCE OF BIOLOGICALLY ACTIVE COMPOUNDS IN SOIL,
Wyoming Univ., Laramie. Dept. of Plant Science.
For primary bibliographic entry see Field 5B.
W89-01778

COMMUNITY TOXICITY TESTING.
A symposium sponsored by ASTM Committee D-19 on Water, Colorado Springs, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. 350p. Edited by John Cairns.

Descriptors: *Toxicity, *Water pollution effects, *Testing procedures, *Bioassay, Water quality, Biological studies, Errors, Ecosystems.

Community level toxicity tests are discussed in this symposium. The tests may be carried out under a variety of circumstances and an example is given of a surrogate for a community level test. Toxicity testing at this particular level of biological organization has a number of advantages. One of the possibilities accompanying the development of community level toxicity testing is that of avoiding the use of application factors. Although community level toxicity testing is now being used for practical purposes, it is not the intent of the book to espouse the use of community level testing in all situations or to replace single-species tests that are the best source of information on growth, reproductive success, behavior, and a variety of other end points. (See W89-01783 thru W89-01799) (Lantz-PTT)
W89-01783

SOME METHODS FOR MEASURING EFFECTS OF TOXICANTS ON LABORATORY- AND FIELD-COLONIZED ESTUARINE BENTHIC COMMUNITIES,
Environmental Research Lab., Gulf Breeze, FL.
M. E. Tagatz.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 18-29, 1 fig, 4 tab, 17 ref.

Descriptors: *Water pollution effects, *Toxicity, *Estuaries, *Benthic environment, *Bioassay, Microcosms, Macroinvertebrates, Field tests, Ecosystems, Species composition.

Effects of toxicants on estuarine macrobenthic animals that developed in sand-filled boxes in the laboratory and field during eight weeks were determined by comparing community structures in control boxes and in boxes treated with a toxicant. Boxes were colonized in the laboratory by planktonic larvae in continuously supplied unfiltered seawater and in the field by animals that occurred naturally. Field boxes were placed in estuarine waters, either near the laboratory or at salt-marsh sites subjected to contamination by mosquito control pesticide applications. Eight separate studies were conducted using the same test materials in laboratory and field tests. Communities that developed were diverse and averaged 1441 individuals, 30 species, and 6 phyla for laboratory tests and 933 individuals, 51 species, and 8 phyla for field tests. Toxicants were introduced via water, air, or sediment and before, during, or after colonization. Tests with laboratory- and field-colonized communities provided corroborating data as well as data unique to each test. Various structural attributes among laboratory, experimental field, and natural field communities were similar, indicating that data derived from the laboratory and field toxicity tests can have good environmental applicability. (See also W89-01783) (Author's abstract)
W89-01785

COMPARISON OF ESTIMATES OF HAZARD DERIVED AT THREE LEVELS OF COMPLEXITY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
B. R. Niederlehner, J. R. Pratt, A. L. Buikema, and J. Cairns.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 30-48, 1 fig, 8 tab, 53 ref.

Descriptors: *Hazard assessment, *Water pollution effects, *Risks, *Cadmium, Ecological effects, Ecosystems, Biological studies, Toxicity, Comparison studies, Performance evaluation, Heavy metals, Protozoa, Aquatic environment.

Cadmium concentrations constituting a threat to aquatic ecosystems were predicted from data collected at two levels of biological hierarchy. A population-level estimate was derived from single-species toxicity test data, and a community-level estimate was derived from toxicity tests on protozoan communities. Estimates were compared with each other and with an ecosystem-level estimate derived from reports of ecological health and ambient cadmium levels in rivers, lakes, and streams. Estimates of permissible acute concentrations differed by an order of magnitude. Single-species toxicity test data suggested that 42 micrograms Cd/L would affect 5% of taxa. The corresponding estimate from the community-level test was 459 micrograms Cd/L. Similar estimates of permissible chronic concentrations were not significantly different (0.82 and 0.20 micrograms Cd/L, single-species and community-level tests, respectively). Both estimates of permissible chronic concentrations fell within a rational range, the minimum defined by median cadmium concentrations in healthy aquatic systems (0.05 micrograms Cd/L) and the maximum defined by median cadmium concentrations in damaged systems (9.2 micrograms Cd/L). (See also W89-01783) (Author's abstract)
W89-01786

SEA URCHIN: BIOASSAY FOR THE ASSESSMENT OF DAMAGE FROM ENVIRONMENTAL CONTAMINANTS,
National Cancer Inst., Fondazione Pascale, I-80131, Naples (Italy).
G. Pagano, M. Cipollaro, G. Corsale, A. Esposito, and E. Ragucci.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 66-92, 9 fig, 8 tab, 68 ref. EEC Commission Contract ENV/554/I-(S).

Descriptors: *Water pollution effects, *Bioassay, *Sea urchins, *Heavy metals, *Toxicity, *Environmental effects, Cadmium, Copper, Zinc, Selenium, Hydrogen ion concentration, Sperm, Reproduction, Animal pathology.

The sea urchin test system has been determined to be an extremely informative bioassay for pollutants, occurring as individual or as mixtures of xenobiotics. Harmful agents may be identified and characterized biologically to given an integrated set of data dealing with several key events, such as fertilization, mitotic activity, and embryogenesis. This study was carried out on some inorganic pollutants (Cd(II), Cu(II), Zn(II), and Se(IV)) and their mixtures. Sublethal pH changes were taken into account as an additional stressor, capable of influencing the toxicities of tested agents. The experiments were performed on Paracentrotus lividus sperm and embryos, and on Echinus esculentus sperm. The results showed distinct patterns of embryotoxicity for the agents tested, which resulted in developmental defects as relatively high levels (> 0.00001 kmol/cu m) for Cd(II) and Se(IV), whereas the embryotoxic effects of Cu(II) and Zn(II) were exerted at lower concentrations (5 times 10 to the -7th power kmol/cu m) close to their natural seawater levels. Cytogenetic analysis of exposed embryos failed to reveal any morphological or quantitative changes in mitotic activity, at embryotoxic levels of all tested contaminants. The fertilization success of exposed sperm showed peculiar dose-response changes, as a result of the specific contaminant levels and of the simultaneous presence of other contaminants. Specifically, slight increases in Cd(II) or Cu(II) levels enhanced fertilization success, up to critical levels (10 to the -7th power to 10 to the -6th power kmol/cu m); however, further increases in these metal ion concentrations led to a drop in fertilization success. The simultaneous presence of Zn(II) or Se(IV) dramatically changed the dose-response patterns, depending on the different mixtures and the test species. (See also W89-01783) (Lantz-PTT)
W89-01787

PRELIMINARY RESULTS OF INTERLABORATORY TESTING OF A STANDARDIZED AQUATIC MICROCOSM,
Washington Univ., Seattle. Coll. of Ocean and Fishery Sciences.
For primary bibliographic entry see Field 5A.
W89-01788

MICROCOSM PROCEDURE FOR DETERMINING SAFE LEVELS OF CHEMICAL EXPOSURE IN SHALLOW-WATER COMMUNITIES,
Oak Ridge National Lab., TN. Environmental Sciences Div.
J. M. Giddings.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 121-134, 2 fig, 16 ref. DOE Contract DE-AC05-84OR21400.

Descriptors: *Microcosms, *Water pollution effects, *Hazard assessment, *Water quality standards, Ecosystems, Aquatic environment, Primary productivity, Toxicity, Population exposure, Ponds, Ecological effects.

A method is described for determining safe levels of chemical exposure in shallow-water communities, using laboratory microcosms as test subjects. The safe level is considered to be the maximum exposure that causes no persistent, ecologically significant changes in the ecosystem. Shallow freshwater communities in ponds, lakes, and rivers are good experimental subjects for research on contaminants, and environmental toxicologists have measured their responses to a variety of chemicals. Certain patterns of community effects have been observed, including a decline in net primary production or the production: respiration ratio, concomitant changes in water chemistry, and changes in community composition brought about by interactions among sensitive and resistant populations. Details of microcosm construction, techniques for monitoring ecological variables in microcosms, and an experimental design for determining safe exposure levels are provided. The microcosms are assembled by transferring components of natural ecosystems to 80L aquaria in a controlled laboratory environment. The communities that develop in these systems are typically dominated by common, cosmopolitan littoral species of macrophytes, algae, and invertebrates. Methods are described for measuring changes in water chemistry, phytoplankton, periphyton, macrophytes, zooplankton, and ecosystem production and respiration. By monitoring these variables over a gradient of pollutant exposure levels, the safe level can be determined accurately and precisely. (See also W89-01783) (Lantz-PTT)
W89-01789

COMPARISON OF MIXED FLASK CULTURE AND STANDARDIZED LABORATORY MODEL ECOSYSTEMS FOR TOXICITY TESTING,
Minnesota Univ.-Duluth. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W89-01790

EVALUATION OF SIMPLE GENERIC AQUATIC ECOSYSTEM TESTS TO SCREEN THE ECOLOGICAL IMPACTS OF PESTICIDES,
Aqua Terra Technologies, Pleasant Hill, CA.
P. J. Sheehan, R. P. Axler, and R. C. Newhook.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 158-179, 4 fig, 6 tab, 26 ref.

Descriptors: *Ecological effects, *Water pollution effects, *Pesticides, Ecosystems, Aquatic environment, Phytoplankton, Bacteria, Zooplankton, Macroinvertebrates, Toxicity, Hazard assessment, Microcosms.

Simple laboratory aquatic ecosystem models composed of naturally coadapted communities of phytoplankton, bacteria, zooplankton, and small benthic invertebrates were developed and evaluated for their effectiveness and consistency in screening the ecological impacts of pesticides on community functions. These generic microcosm toxicity tests were used to rank the potential hazard of pesticides on community metabolic process. The reproducibility of hazard rankings was evaluated in sequential experiments with the same microcosm inoculum, and simultaneous experiments using two sets of microcosms with taxonomically different community inocula, but the same major functional groups present (i.e., primary producers, grazers, detritivores, and decomposers). Based on an integrated measure of system response, relative impact, which accounts for both the magnitude and duration of displacement of defined treatment effects from the normal range of control system functions, these generic test systems were remarkably consistent in ranking pesticide impacts on community metabolic activities. (See also W89-01783) (Author's abstract)
W89-01791

POPULATION AND GUILD ANALYSIS FOR INTERPRETATION OF HEAVY METAL POLLUTION IN STREAMS,
Lund Univ. (Sweden). Limnological Inst.
R. C. Petersen.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 180-198, 10 fig, 4 tab, 46 ref.

Descriptors: *Water pollution effects, *Heavy metals, *Streams, *Toxicity, Kolbackson River, Sweden, Guilds, Macroinvertebrates, Caddisflies, Ecological effects.

The analysis of several closely related species, a guild, may be a practical and informative technique for studying the ecological effects of toxic substances. The five criteria of taxonomic simplicity, commonness, sensitivity, available literature, and laboratory practicality define guilds appropriate for community toxicity testing. As an example, the benthic macroinvertebrate community and a guild of three coexisting species of the caddisfly larva, Hydropsyche, were analyzed along a Swedish river, Kolbacksan, with a history of heavy metal pollution. There was an increase in the relative proportion of early instar H. siltalai within the guild with increasing heavy metal pollution. The increase in early instar H. siltalai was correlated with a decrease in later instar H. pellucidula. More severe disturbances resulted in the removal of H. pellucidula and a reduction in H. siltalai density, while the more tolerant species, H. angustipennis, remained unchanged. Analysis of the guild leads to the conclusion that metal pollution not only eliminates species and reduces population density but changes interspecific interactions among members of the guild. (See also W89-01783) (Author's abstract)
W89-01792

IMPACT OF DRILLING FLUIDS ON SEAGRASSES: AN EXPERIMENTAL COMMUNITY APPROACH,
University of West Florida, Pensacola. Dept. of Biology.
R. D. Morton, T. W. Duke, J. M. Macauley, J. R. Clark, and W. A. Price.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 199-212, 2 fig, 4 tab, 22 ref. EPA Contract CR-811649.

Descriptors: *Drilling fluids, *Sea grasses, *Ecological effects, *Water pollution effects, Aquatic plants, Macroinvertebrates, Biological studies, Microcosms, Toxicity, Oil, Clay.

Effects of a used drilling fluid on an experimental seagrass community (Thalassia testudinum Konig et Sims) were measured by exposing the community to the suspended particulate phase (SSP) in laboratory microcosms. Structure of the macroinvertebrate assemblage, growth and chlorophyll content of grass and associated epiphytes, and rates of decomposition as indicated by weight loss of grass leaves in treated and untreated microcosms were compared. Health of the plants and structure of the macroinvertebrate assemblage maintained in the laboratory were compared periodically with the seagrass community from which the plants and attendant sediment were taken. Treated microcosms were exposed to either 190 parts per million (ppm), volume to volume, of SPP or an equivalent amount of montmorillonite clay. Untreated microcosms received only flowing water from Santa Rosa Sound. Sixteen replicates were provided for each treated and untreated set. Sensitivity of the community compared well with sensitivity of single species tested with the same drilling fluid for shorter periods of time. In other toxicity tests with marine organisms and drilling fluids, there was a direct correlation between toxicity and concentration of diesel oil. Thus, diesel in the drilling fluid probably contributed to effects on the structure and function of the microcosms. This was evident in the degradation rate of seagrass, where a significant effect was measured with drilling fluid but not in the clay treatment. The role of diesel was less clear in the reduction of numbers of macroinvertebrates, where both drilling fluid and clay treatments had similar effects. (See also W89-01783) (Lantz-PTT)
W89-01793

SIMPLE IN-STREAM TEST OF LABORATORY FINDINGS THAT NTA PROTECTS FISH AND INVERTEBRATES AGAINST COPPER AND ZINC,
Guelph Univ. (Ontario). Dept. of Zoology.
J. B. Sprague.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 213-223, 2 fig, 3 tab, 17 ref.

Descriptors: *Nitrilotriacetic acid, *Copper, *Zinc, *Fish, *Water pollution effects, *Water pollution treatment, Lethal limits, Invertebrate, Heavy metals, Benthic environment, Toxicity, Chelating agents, Water quality control.

The chelating agent NTA (nitrilotriacetic acid) eliminated acute lethality of zinc and copper during 4 days of experimental dosing in a small creek. Caged salmon died in 4 h in the 'polluted' zone, where added metals were 4 to 7 times the lethal threshold and dead wild eels were also found. Downstream, with equi-molar NTA added, caged fish survived without marked signs of stress, and normal behavior of a wild eel was noted. Benthic invertebrates were much more tolerant of metals than anticipated, and subtle changes in the community could not be documented by the deliberately minimal design of the experiment (pairs of Surber samples before and after treatment). The only demonstrated change in numbers was the virtual disappearance of blackfly larvae in the polluted zone, with no change in the control and antipolluted zones. Cluster analysis of benthic samples also suggested effectiveness of NTA; the two polluted samples were distinct from a grouping which contained all other samples ('clean,' 'before,' and 'antipolluted'). No effects were demonstrated for diversity index, genera, or total numbers. As a side-issue, the experiment demonstrated that immature stoneflies and caddisflies, but not blackflies, can survive for 4 days in concentrations of zinc and copper that are at least 4 times the lethal level for salmonid fish. The relative tolerances of other taxa were uncertain because of small sample size, high variance, and few replicates. (See also W89-01783) (Author's abstract)
W89-01794

EFFECT OF 3-TRIFLUOROMETHYL-4-NITROPHENOL ON THE STRUCTURE AND FUNCTION OF PROTOZOAN COMMUNITIES ESTABLISHED ON ARTIFICIAL SUBSTRATES,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
For primary bibliographic entry see Field 5A.
W89-01795

STRUCTURAL AND FUNCTIONAL RESPONSE OF NATURAL PHYTOPLANKTON AND PERIPHYTON COMMUNITIES TO A CATIONIC SURFACTANT WITH CONSIDERATIONS ON ENVIRONMENTAL FATE,
Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
M. A. Lewis, M. J. Taylor, and R. J. Larson.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 241-268, 4 fig, 9 tab, 59 ref.

Descriptors: *Phytoplankton, *Periphyton, *Surfactants, *Water pollution effects, Toxicity, Photosynthesis, *Ecological effects, Lethal limits, Data collections, Algae, Cations, Biological studies.

The effects of a cationic surfactant were evaluated in field experiments with natural algal assemblages to validate the laboratory toxicity data base. Response parameters monitored in studies of 3 h to 21 days duration included structural and functional community characteristics in addition to more standard growth measurements. Photosynthesis and community similarity were typically the more sensitive parameters and a diversity index the least sensitive. The median effective concentration (EC sub 50) values based on phytosynthetic activity ranged from 0.4 to 6.1 mg/L. Phytoplankton were first affected in situ between 0.03 and 1.99 mg/L, relative to an effect level between 0.21 and 0.96 mg/L for periphyton. Periphyton colonized and exposed in river water containing 25% effluent were first affected at 6.9 mg/L. A mean in-stream concentration of 0.25 mg/L had no adverse effect on the indigenous periphyton of a small Indiana stream based on comparison of three-week pre- and post-exposure community analysis. Rapid biodegradation was observed in the field experiments. The field-derived effect concentrations were compared with those determined in standard laboratory toxicity tests for four cultured algal species. The laboratory first-effect and EC sub 50 levels for these single species were typically lower. Overall, the multispecies tests proved valuable in providing perspective on the potential for an environmental impact from this surfactant that could not be demonstrated in the laboratory using current standard testing methodologies. (See also W89-01783) (Author's abstract)
W89-01796

USE OF LIMNOCORRALS IN EVALUATING THE EFFECTS OF PESTICIDES ON ZOOPLANKTON COMMUNITIES,
Guelph Univ. (Ontario). Dept. of Environmental Biology.
N. K. Kaushik, K. R. Solomon, G. L. Stephenson, and K. E. Day.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 269-290, 9 fig, 7 tab, 40 ref.

Descriptors: *Pesticides, *Zooplankton, *Water pollution effects, *Spatial distribution, *Limnocorrals, Ecological effects, Methyoxychlor, Corrals, Zooplankton, Permethrin, Pesticides, Chlorinated hydrocarbons, Spatial distribution, Crustaceans, Rotifers, Biological studies, Toxicity.

Enclosures of three sizes (large, 1000 cu m; medium, 125 cu m; small, 20 cu m) designed and constructed specifically to facilitate the evaluation of the impact of pesticides in freshwater ecosystems are described. Uniform mixing of permethrin in a corral was possible within an hour using a pump system that had no adverse effects on entrapped organisms. Methyoxychlor applied to surface waters with a back-pack spray system penetrated the column of water within 24 h. Both application methods produced replicable concentrations close to the desired nominal concentration. As a result of the impact of permethrin (0.5 and 5.0 micrograms/L) and methoxychlor (5 and 50 micrograms/L), densities of macrozooplankton populations decreased and rotifer populations increased in numbers. As the macrozooplankton populations recovered, rotifer numbers decreased. The large corrals possessed a distinctive edge zone that extended 1.0 m from the corral wall and was usually characterized by greater densities of macrozooplankton than the center zone. No such edge zone existed in the small or medium corrals. The authors recommend that the spatial distribution of zooplankton in each size of corral be defined before establishing a sampling regime; thus more precise population estimates may be attained. The impact of methoxychlor on enclosed zooplankton populations differed in the three sizes of limnocorrals. The toxicity of 20 micrograms methoxychlor/L to zooplankton increased with increasing size of corral, primarily because of the decreasing ratio of surface area of limnocorral walls to water volume. Methoxychlor adsorbs readily to polyvinyl chloride; thus the concentration in the water of the larger enclosures was higher for a longer period of time than that in the smaller corrals. (See also W89-01783) (Author's abstract)
W89-01797

ZOOPLANKTON COMMUNITY RESPONSES TO SYNTHETIC OIL EXPOSURE,
Science Applications International Corp., Oak Ridge, TN.
L. A. Hook, P. J. Franco, and J. M. Giddings.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Pub-

lication 920, 1986. p 291-321, 12 fig, 2 tab, 19 ref. DOE Contract DE-AC05-84OR21400.

Descriptors: *Zooplankton, *Ecological effects, *Oil pollution, Organic compounds, Bioassay, Toxicity, Lethal limits, Field tests, Daphnia, Crustaceans, Rotifers, Monitoring, Principal component analysis, Microcosms, Ecosystems.

While direct toxicant effects on populations can be estimated from single-species bioassay results, the complete range of population and community responses can best be investigated at the ecosystem level. The objectives of this research were: (1) to determine the effects of a contaminant (a coal-derived light distillate oil) on the zooplankton communities of laboratory pond microcosms and outdoor experimental ponds; (2) to compare responses of microcosm and field zooplankton communities with each other and with laboratory bioassay data; and (3) to explore the use of community structure data for impact detection. The responses of the microcosm and pond zooplankton communities to oil treatment were quite similar. Their close agreement lends support for using shallow-water pond microcosms as surrogates for field experiments in hazard evaluation. Changes in cladoceran densities were the most sensitive indicators of stress in the zooplankton communities. Copepods were slightly less sensitive, and rotifers were least sensitive to oil treatment. Indirect effects on populations were observed at intermediate treatment levels. The lowest treatment levels at which persistent and significant ecological changes occurred were the same in both systems. These levels were similar to the lowest observed-effect concentration for the Daphnia magna chronic bioassay, or approximately 35 or the D. magna 48-h LC sub 50. Community structure responses were generally consistent between systems; however, sensitivity for detecting oil treatment effects varied greatly among the measures of community structure. Species richness and diversity measures were not as sensitive as individual species responses. Cluster and multivariate post-clustering analyses of community similarity values reflected indirect effects and had sufficient sensitivity to allow early impact detection. An expanded principal components technique, which used both zooplankton and water quality data, was also relatively sensitive and would be applicable for routine monitoring. (See also W89-01783) (Author's abstract)
W89-01798

PRODUCTION OF COEXISTING JUVENILE COHO SALMON AND STEELHEAD TROUT IN HEATED MODEL STREAM COMMUNITIES,

Northrop Services, Inc., Corvallis, OR.
R. M. Hughes, and G. E. Davis.
IN: Community Toxicity Testing. A Symposium Sponsored by ASTM Committee D-19 on Water, Colorado Spring, Colorado, May 6-7, 1985. American Society for Testing and Materials, Philadelphia, Pennsylvania. ASTM Special Technical Publication 920, 1986. p 322-337, 8 fig, 37 ref. OWRT GRant B-041-ORE.

Descriptors: *Salmon, *Trout, *Thermal pollution, *Streams, *Bioassay, *Water pollution effects, Ecological effects, Water temperature, Biomass, Primary productivity, Nutrition, Artificial watercourses, Fish, Macroinvertebrates.

A 4 C temperature differential was maintained between two model streams Steelhead trout (Salmo gairdneri) were introduced as embryos and retained for one year. The following year, steelhead and coho salmon (Oncorhynchus kisutch) were introduced as embryos and retained together. Macroinvertebrates and fish were sampled every three weeks. Primary production and respiration were estimated seasonally. Prey biomass and diversity, and the production, biomass, and numbers of steelhead and coho were generally lower in the heated stream than in the control stream. Production, biomass, and numbers of steelhead were lower than those of coho and lower when coho were present than when they were absent. It was concluded: (1) that moderate temperature elevation can decrease the productivity of streams for steelhead and coho when food is limited; (2) that coho might reduce the productivity of streams for steelhead more than temperature elevation might; and (3) that model stream results are more likely to corroborate single-species bioassays of fish fed limited rations than of fish fed to repletion. (See also W89-01783) (Author's abstract)
W89-01799

PROCEEDINGS OF THE FOREST-ATMOSPHERE INTERACTION WORKSHOP.

For primary bibliographic entry see Field 5B.
W89-01815

ECOLOGICAL PERSPECTIVES ON WETLAND SYSTEMS,

Wisconsin Univ.-Milwaukee. Dept. of Botany.
For primary bibliographic entry see Field 2H.
W89-01832

EFFECTS OF WASTEWATER ON WETLAND ANIMAL COMMUNITIES,

Lake Michigan Federation, Chicago, IL.
K. M. Brennan.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 199-223, 3 fig, 71 ref. EPA Contract 68-01-5989.

Descriptors: *Wetlands treatment, *Wastewater treatment, *Water pollution effects, *Wetlands, *Ecosystems, *Wildlife, *Environmental effects, Literature review, Economic aspects, Artificial wetlands.

An inventory of known discharges of wastewater to wetlands in Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin was performed. The results show that the use of natural wetlands for the discharge of treated wastewater is relatively common. However, the intentional inclusion of wetlands as part of the treatment process is rare. Both types of situations may become more attractive due to economic factors. Although the short-term benefits of the use of natural wetlands for the disposal or treatment of wastewater (cost-effectiveness, treatment efficiency, and convenience) appear promising, the long-term ability of these areas to treat wastewater is questionable. The construction of artificial wetlands for the treatment of wastewater would avoid any detrimental effects that might result from the use of natural wetlands and also could provide supplementary habitats for wetland wildlife and possibly reservoirs for rare species. Few animal-related studies have been performed at the small number of artificial wetland sites presently in existence; thus, the information base is too small and too short-term for any conclusions to be drawn. (See also W89-01827) (Lantz-PTT)
W89-01840

TERRESTRIAL COMMUNITIES: FROM MESIC TO HYDRIC,

Bowling Green State Univ., OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5E.
W89-01841

PUBLIC HEALTH IMPLICATIONS OF SEWAGE APPLICATIONS ON WETLANDS: MICROBIOLOGICAL ASPECTS,

Massachusetts Univ. at Boston. Dept. of Biology.
M. P. Shiaris.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 243-261, 1 fig, 5 tab, 45 ref.

Descriptors: *Public health, *Wastewater disposal, *Wetlands, *Wetlands treatment, *Microbiological studies, *Water pollution effects, Microorganisms, Wastewater treatment, Bacteria, Viruses, Biological treatment, Toxicity, Hazardous wastes, Ecosystems, Bioaccumulation.

Microorganisms occupy a central role in wastewater relations to public health. The following highlights summarize the state-of-knowledge of microbiological health implications for wetland treatment systems: (1) Bacterial pathogens are well understood in wastewater environments. Organisms of major concern to human health are Salmonella spp., Shigella spp., Campylobacter fetus, and Leptospira spp. Of all the pathogens, bacteria are the most susceptible to conventional treatments; (2) Viruses of major concern to public health include hepatitis A virus, rotavirus, and enteroviruses, which are the major agents of waterborne disease in the United States. Traditional indicators of fecal pollution are not reliable indicators of viral pollution. Viruses tend to be more persistent in aquatic environments than bacteria, and no single virus may serve as a universal indicator of viral pollution. Improved techniques are required for the detection and enumeration of viral pathogens; (3) Microorganisms in wastewaters play an important role as detoxifying agents. However, the extent of pollutant detoxification in aquatic systems is not well understood; (4) Microorganisms also have the potential to transform relatively nontoxic compounds to toxic forms. The extent of this phenomenon in wastewater is not known; (5) Indirectly, microorganisms may contribute to detrimental public health conditions in aquatic ecosystems. Hazardous metabolic wastes, such as nitrite, may potentially accumulate in the environment, or the microbial biomass may act as a source for the bioaccumulation of toxins in the wetlands food chain. (See also W89-01827) (Lantz-PTT)
W89-01843

SOME LONG-TERM CONSEQUENCES OF SEWAGE CONTAMINATION IN SALT MARSH ECOSYSTEMS,

Marine Biological Lab., Woods Hole, MA.
I. Valiela, J. M. Teal, C. Cogswell, J. Hartman, and S. Allen.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 301-316, 7 fig, 2 tab, 25 ref. NSF Grants GA-43009, OCE74-27859, DEB-7905127, DEB-8012437, and NOAA Grant 04-8-M01-149.

Descriptors: *Salt marshes, *Water pollution effects, *Wastewater disposal, *Eutrophication, *Ecological effects, Ecosystems, Nutrients, Wetlands.

A scheme of how a salt-marsh plant community may be structured is presented. It preliminary and simplified, but it does provide some important notions in regard to long-term effects of sewage contamination: (1) Any eutrophication that occurs will affect the balance among the components of salt-marsh biota; (2) Many of the mechanisms involved in the transition from one kind of patch to another take time, from less than a year to perhaps several years. In the field, the changes that follow eutrophication may consist of a chain of such transitions such that there will necessarily be a continuing string of changes over considerably long periods of time; (3) Even at the highest dosage of sewage fertilizer, detrimental effects to the plant species have not been found, even though the fertilizer used contains many elements and compounds that are potentially toxic. Perhaps salt-marsh plants, because of their adaptation to life in anaerobic substrates where, for example, metals are abundant, are tolerant of the presence of many kinds of toxic materials; (4) Since nutrient-enrichment experiments did not bring about the demise of organisms through toxic effects, it is very difficult to argue that this degree of eutrophication degrades a salt-marsh community. Eutrophication can exert subtle but profound influence on the structure of communities, and many of the changes will take place over considerable periods of time. Manipulative approaches, such as applied here, are the most effective way to gain insight into the mechanisms involved and furnish the evidence with which to predict at least some of the consequences of eutrophication. (See also W89-01827) (Lantz-PTT)
W89-01847

LONG-TERM IMPACTS OF AGRICULTURAL RUNOFF IN A LOUISIANA SWAMP FOREST,

Louisiana State Univ., Baton Rouge. Center for

Wetland Resources.
For primary bibliographic entry see Field 4C.
W89-01848

RESPONSES OF WETLANDS AND NEIGHBORING ECOSYSTEMS TO WASTEWATER,
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
K. C. Ewel.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 435-438, 1 fig.

Descriptors: *Water pollution effects, *Ecological effects, *Wetlands, *Wetland treatment, *Wastewater treatment, Environmental protection, Oxygen deficit, Stress, Ecosystems, Nutrients, Vegetation, Carbon, Productivity.

The use of wetlands for treatment of wastewater is clearly an attractive alternative to construction and maintenance of advanced wastewater treatment plants. Several types of wetlands have been assayed for their ability to provide an acceptable level of treatment, and patterns are emerging to indicate which kinds of wetlands might be most suitable in different geographic regions. However, full-scale implementation of the use of both natural and artificial wetlands is proceeding more rapidly than is initiation of the additional careful, in-depth research projects needed to verify and round out the information that has already been collected. The responses of species composition and productivity in plant communities to wastewater addition show no conspicuous pattern across the spectrum of ecosystems that has been considered in this workshop. Anoxia in the rhizosphere is probably the most stressful aspect of a wetland plant environment, and diversity usually decreases with longer anoxic period. Nutrient addition has a much more direct effect on gross primary productivity than on species composition. Intolerance of the existing plant community to a longer hydroperiod is probably the major factor involved in immediate changes that occur in wastewater-enriched wetlands. High public health standards and shrinking energy supplies indicate that increasing use of natural ecosystems will be necessary to absorb the wastes of growing populations. However, the need to understand and maintain the basic functions of natural ecosystems dictates that advances in this direction be made only with the greatest care and planning. (See also W89-01827) (Lantz-PTT)
W89-01856

WETLANDS, WASTEWATER, AND WILDLIFE,
Utah State Univ., Logan. Dept. of Wildlife Science.
J. A. Kadlec.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 439-443, 12 ref.

Descriptors: *Wetlands, *Wastewater treatment, *Wildlife, *Water pollution effects, *Wetland treatment, *Ecological effects, Primary productivity, Vegetation, Species diversity, Pathogens, Toxicity, Ecosystems, Disease, Nutrients.

Data on the effects on wildlife of wastewater inputs to wetlands are scarce. As a consequence, an attempt was made to examine the documented and predicted effects of wastewater on wetlands and then to interpret those effects in terms of their potential impact on wildlife. For convenience, wastewater effects on wetland ecosystems are categorized into five major categories: (1) primary production, (2) plant community structure, (3) water regime, (4) pathogens, and (5) toxic chemicals. These categories are not mutually exclusive and there are important interactions among categories, but each category serves to focus attention on a particular set of concerns. Considerations of the potential impacts of wastewater on wildlife in wetlands has deliberately tended to emphasize the negative. Clearly, the potential for both positive and negative impacts on species or groups of species exists. Change is most likely, but that change may be good or bad depending on the circumstances and the human value judgments of that time and place. Most worrisome are the potential problems with disease and toxic chemicals. Experience to date suggests that nutrient additions, at least in the relatively short term, are not a problem for wildlife, except that the wildlife community will change as the plant community changes. (See also W89-01827) (Lantz-PTT)
W89-01857

AQUATIC TOXICOLOGY AND ENVIRONMENTAL FATE: NINTH VOLUME.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 5B.
W89-01892

PROPOSED GOAL OF APPLIED AQUATIC TOXICOLOGY,
Environmental Research Lab.-Duluth, MN.
C. E. Stephan.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 3-10, 14 ref.

Descriptors: *Aquatic toxicology, *Environmental effects, *Water quality standards, *Ecological effects, Future planning, Ecosystems, Hazard assessments, Toxicity.

It is proposed that 'A major goal of applied aquatic toxicology is to be able to make a useful prediction concerning whether or not a specific addition of a toxic agent to a particular aquatic ecosystem will cause any unacceptable effect on that ecosystem.' If this is a valid goal, it is important to the future of applied aquatic toxicology that biologists, ecologists, toxicologists, and others concerned with environmental protection reach some agreement concerning practical ways of distinguishing between acceptable and unacceptable effects on aquatic ecosystems. Without a useful definition of 'unacceptable effects,' it is difficult to determine the validity of hazard assessments, water quality criteria, and tools for predicting effects. Definitions are discussed, and should be considered suggestions meant to illustrate some possibilities. Because they have a need for a definition, aquatic toxicologists should take the initiative and begin working with biologists, ecologists, and others concerned with environmental protection to reach some agreement concerning an appropriate operational definition of unacceptable effects on aquatic ecosystems. (See also W89-01892) (Lantz-PTT)
W89-01893

TOWARD A MEANINGFUL INTERACTION BETWEEN ECOLOGY AND AQUATIC TOXICOLOGY,
Utah State Univ., Logan.
J. M. Neuhold.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 11-21, 10 ref.

Descriptors: *Ecological effects, *Aquatic toxicology, *Toxicology, Bioassay, Environmental effects, Toxicity, Population exposure, Ecosystems.

Single species toxicity tests, microcosm toxicity tests, and ecosystem level field studies all have their advantages and limitations in determining the effect of a toxicant on an ecosystem. In spite of their limitations, laboratory toxicity studies are necessary for gaining autecological insights to how organisms respond. Microcosm tests are a first approximation to how an ecosystem might respond to the intrusion of a toxicant. Population, community, and ecosystem level field studies are necessary to interpret laboratory findings from single species and microcosm tests in light of the field realities. (See also W89-01892) (Author's abstract)
W89-01894

SYSTEMS ECOLOGY AND ENVIRONMENTAL LAW: DO THEY SPEAK THE SAME LANGUAGE,
Envirosphere Co., Bellevue, WA.
For primary bibliographic entry see Field 6E.
W89-01895

DESIGN CRITERIA FOR A PREDICTIVE ECOLOGICAL EFFECTS MODELING SYSTEM,
Environmental Research Lab., Athens, GA.
R. R. Lassiter.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 42-54, 7 ref.

Descriptors: *Toxicology, *Environmental impact, *Water pollution effects, *Model studies, *Ecological effects, Design standards, Mathematical models, Aquatic toxicology, Toxicity, Prediction.

The capability to predict the environmental fate of chemicals based on their chemical properties is well developed and widely practiced. Poorly developed, however, is the capability to predict the effects of those chemicals. To address this deficiency, significant effort has been directed to the creation of mathematical models to predict the effects of toxicants in aquatic systems. These models consist of two parts: an ecological component and a toxicological component. The ecological components are organized at levels of integration and resolution intended to be relevant to the kinds of expected problems and questions to be addressed in determining whether to permit or prohibit the use of a new chemical. Models of systems in which the organisms are assumed to have reached steady state with respect to the level of toxicant are at a fine scale of resolution. A toxicological model in corresponding detail is associated with each level to provide predictions of effects. This model assumes for all levels that a common threshold concentration exists at which the organism dies. With this assumption, a model for exchange with the environment and assumptions of rapid internal distribution of the toxicant, the time to death for an individual depends on the fraction of its body comprised of fat. Probability of death by the end of a fixed exposure time is a function of the statistical distribution of the fraction of fat in the organisms' bodies. (See also W89-01892) (Author's abstract)
W89-01896

RESOURCE COMPETITION MODELING OF THE IMPACTS OF XENOBIOTICS ON BIOLOGICAL COMMUNITIES,
Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD.
W. G. Landis.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 55-72, 11 fig, 17 ref.

Descriptors: *Toxicology, *Water pollution effects, *Model studies, *Xenobiotic compounds, *Environmental effects, Path of pollutants, Graphical analysis, Biological studies, Aquatic toxicology, Toxicity, Ecosystems, Environmental impact.

The current research takes advantage of multidimensional isocline graphical methods to describe competition for resources. These models proved useful based on the assumption that the toxin impacts the efficiency of at least one metabolic pathway. This loss of efficiency subsequently transforms the consumption vector and causes an increase in the minimum levels of resources needed to result in a zero net growth of the population. The models produced a variety of results. Regions of equilibria expanded, contracted, or shifted to new regions of the resource space. Interestingly, conditions that produced the largest regions of competitive equilibria are similar to conditions that theoretically could lead to extinction of a species. Spatial and temporal heterogeneity also masked

the impact of a toxin from indexes of diversity or other measures of community structure. The impact of a toxin was also dependent on the class of resource (substitutable, essential, switching, etc.) affected. Genetic diversity could also be added as a component to the system. Higher order trophic interactions were also modeled. A two-dimensional resource space can be altered to include the growth rate of the populations being modeled as the third axis. The resource supply for the next trophic level can then be calculated. Effects of the addition of the toxicant can then be followed through the organization of a biological community. An important aspect of this particular approach is that the models are deterministic and the data necessary to construct the graphics can be obtained experimentally. The models also point to severe shortcomings in the toxicity assays. In acute assays, reproductive parameters are not addressed. Common reproductive assays do not look at the effects of varying resource levels. A major use of the model can be in the design of toxicity testing methods to predict community-level effects. (See also W89-01892) (Author's abstract)
W89-01897

PHENOMENOLOGICAL PERSPECTIVE OF ECOLOGICAL DEVELOPMENT,
Maryland Univ., Solomons. Chesapeake Biological Lab.
R. E. Ulanowicz.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 73-81, 3 fig, 17 ref.

Descriptors: *Toxicology, *Environmental effects, *Ecosystems, *Aquatic toxicology, *Theoretical analysis, *Ecological effects, Eutrophication.

The most direct and realistic approach to quantifying ecosystems is to measure their supporting networks of flows of materials and energy. The growth and development of such networks may be quantified by applying information theory to the data on flows. Once development has been formalized, other subjective notions, such as 'eutrophication' and ecosystem 'health,' take on more precise, quantitative significance. (See also W89-01892) (Author's abstract)
W89-01898

POPULATION AND ECOSYSTEM THEORY IN ECOLOGICAL RISK ASSESSMENT,
Oak Ridge National Lab., TN. Environmental Sciences Div.
L. W. Barnthouse, R. V. O'Neill, S. M. Bartell, and G. W. Suter.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 82-96, 85 ref. EPA Contract DW89930292-01-0 and DOE Contract DE-AC05-84OR21400.

Descriptors: *Toxicology, *Aquatic toxicology, *Risk assessment, *Ecological effects, *Water pollution effects, Environmental effects, Ecosystems, Fish, Population exposure.

Assessments of ecological risks associated with toxic contaminant releases necessarily involve extrapolation from observed responses of simplified laboratory systems to predicted responses of complex natural systems. Evaluated here is the utility of population and ecosystem theory for making these extrapolations, based on: (1) the success of the theory when applied to other environmental assessment and resource management problems, and (2) the degree of scientific consensus concerning the appropriate approaches to modeling populations and ecosystem. The applications reviewed include fisheries management, water quality assessment and management, and power-plant-impact assessment. The authors conclude that neither population nor ecosystem theory can now provide models that accurately predict the long-term ecological consequences of toxic contaminant releases. However, how short-term effects of toxic contaminants on fish populations can be projected by use of models employed in fisheries management is illustrated. Further, shown is how ecosystem theory can, in spite of its relative immaturity, make immediate contributions to understanding the qualitative responses of complex ecological systems to toxic contaminants. (See also W89-01892) (Author's abstract)
W89-01899

PROTECTING AQUATIC RESOURCES: AN ECOLOGIST'S PERSPECTIVE,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5G.
W89-01900

LABORATORY SIMULATION OF FISH PASSAGE THROUGH A HEATED-WATER DISCHARGE,
Battelle Pacific Northwest Labs., Richland, WA.
D. A. Neitzel, T. M. Poston, T. L. Page, and C. S. Abernethy.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 122-134, 8 fig, 10 ref. DOE Contract DE-AC06-76RL0 1830.

Descriptors: *Thermal water, *Simulation analysis, *Fish passages, *Water pollution effects, Salmon, Fish, Water temperature, Thermal stress, Thermal pollution, Squawfish.

The Pacific Northwest Laboratory conducted laboratory simulations of fish passage through a heated-water discharge to assess the potential for direct and indirect mortalities to Columbia River fish. Laboratory simulations provided better data for assessment than was available in the published literature and was more specific to the assessment criteria than was possible with data collected from in-plume exposures of fish or field monitoring of fish populations near the outfall. The simulation was conducted with chinook salmon, coho salmon, steelhead, and northern squawfish. Simulations were conducted in aquaria plumbed to receive and discharge heated water that simulated the thermal conditions a fish would encounter swimming downstream through the plume. The rate of exchange for the water and the initial temperature were varied to simulate conditions through different portions of the plume and for different river flows. Fish that survived passage through the plume were subjected to predators or to an infectious disease organism to test for the possibility of indirect mortality from thermal stress. Fish were able to survive passage through a plume where the initial increase in water temperature was 16 C above ambient. The maximum ambient water temperature tested was 18.3 C, which is the maximum temperature expected near the discharge. The fish that survived the thermal stress were not susceptible to increased predation or disease. (See also W89-01892) (Author's abstract)
W89-01902

USE OF HELIOPHRYA SP., A SESSILE SUCTORIAN PROTOZOAN, AS A BIOMONITOR OF URBAN RUNOFF,
Georgetown Univ., Washington, DC. Dept. of Biology.
P. G. Sayre, D. M. Spoon, and D. G. Loveland.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 135-153, 5 fig, 2 tab, 44 ref.

Descriptors: *Toxicology, *Pollutant identification, *Bioindicators, *Protozoa, *Urban runoff, *Monitoring, *Water pollution effects, Bioassay, Biological studies, Aquatic toxicology, Hydrocarbons, Oil pollution, Fathead minnows.

Heliophrya sp. readily attaches to artificial substrates, is convenient for manipulation in the lab or field, and survives on a monthly feeding of ciliates. Plastic petri dishes with 20 Heliophrya in replicates were placed at three stations along a tributary (Hickey Run) of the Anacostia River that received chronic oil pollution. One station in a tributary of Hickey Run with minimal pollution was considered the control. Oil concentrations in field and laboratory water samples were determined using gas chromatography and gas chromatography/mass spectrometry. The dominant aromatic hydrocarbons were ethyl and methyl benzenes, ethyl and methyl napthalenes, indenes, biphenyls, and phenanthrenes. The dominant n-alkanes fell in the C7 to C22 range. In a 48-h field study, death of Heliophrya at the polluted stations in Hickey Run was not significantly greater than at the control station in the tributary. Daphnia pulex was eliminated at all three polluted stations, but had a mean survival of 80% (s = 14.1) at the control station. A 48-h lab study using dilutions from the most polluted station produced a similar mortality response for Heliophrya. In the 48-h lab study, the Daphnia LC sub 50 was 786 ppb of total hydrocarbons. Following anhydrobiosis, Heliophrya were more susceptible to hydrocarbons, suggesting two levels of sensitivity for the same organism. Heliophrya exposed for seven days in the field had estimated LC sub 50s of 1.0 ppm for aromatic and 28.9 ppm for total hydrocarbon concentrations. Heliophrya provides a companion biomonitor for Daphnia in field and laboratory studies, with Daphnia the acute time span biomonitor and Heliophrya the biomonitor for chronic studies. The ability of Heliophrya to permanently attach to a substratum, starve for up to a month, and resist physical damage supports its use as a companion biomonitor to the more sensitive Daphnia. (See also W89-01892) (Lantz-PTT)
W89-01903

STRATEGY FOR WHOLE EFFLUENT TOXICITY EVALUATIONS IN NORTH CAROLINA,
North Carolina Dept. of Natural Resources and Community Development, Raleigh. Div. of Environmental Management.
K. W. Eagleson, S. W. Tedder, and L. W. Ausley.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 154-160, 2 fig, 1 tab.

Descriptors: *Water pollution effects, *North Carolina, *Aquatic toxicology, *Wastewater disposal, *Toxicology, *Wastewater treatment, Biological studies, Ecological effects, Compliance.

Historically, treatment and, therefore, compliance activities associated with wastewater treatment facilities have focused on conventional pollutants. Whereas this approach has enhanced the protection of water quality, it has not intensively addressed the problems of toxic pollutants. The Water Quality Program in North Carolina has redirected and increased activities addressing the issue of toxic discharges. Biological approaches that include ecological studies and aquatic toxicological evaluations have proven to be useful tools in the determination of impacts to aquatic ecosystems. These approaches applied concurrently with analytical determinations have resulted in a more effective compliance program and have received substantial support from administrative officials, regulators, industry, and municipalities. (See also W89-01892) (Author's abstract)
W89-01904

FIELD AND LABORATORY TOXICITY TESTS WITH SHRIMP, MYSIDS, AND SHEEPSHEAD MINNOWS EXPOSED TO FENTHION,
Environmental Research Lab., Gulf Breeze, FL.
J. R. Clark, L. R. Goodman, P. W. Borthwick, J. M. Patrick, and J. C. Moore.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-

16, 1985. ASTM Special Technical Publication 921, 1986. p 161-176, 3 fig, 2 tab, 6 ref.

Descriptors: *Bioindicators, *Toxicology, *Pesticides, *Aquatic toxicology, *Toxicity, *Shrimp, *Mysids, *Minnows, *Fenthion, *Water pollution effects, Bioassay, Lethal limits, Insecticides.

A series of laboratory pulse-exposure experiments were conducted to model short-term field exposures of two representative estuarine crustaceans, Penaeus duorarum and Mysidopsis bahia, to the organophosphate insecticide fenthion. These tests established acutely lethal and nonlethal concentrations during pulse exposures. The data were necessary for interpretation of responses of test animals in the field when fenthion concentrations changed rapidly with time. The toxicity of fenthion to caged pink shrimp, mysids, and sheepshead minnows was determined in the field following two aerial applications separated by 72 h, to control adult saltmarsh mosquitoes. At one estuarine site, initial concentrations of fenthion in water were 1.5 micrograms/L following Spray 1 and 0.29 micrograms/L after Spray 2. Within 12 to 24 h, however, fenthion was not detectable (< 0.02 micrograms/L) because of rapid tidal flushing and high dilution at this site. Although initial exposures approached or exceeded laboratory 24-h LC sub 50s for pink shrimp (0.40 micrograms/L) and mysids (0.42 micrograms/L), no mortality occurred among caged animals. At a second site along a residential saltwater canal with limited tidal flushing and dilution, initial concentrations of fenthion were 2.6 micrograms/L (Spray) and 0.5 micrograms/L (Spray 2) and continued to diminish during the next 48 to 72 h. These concentrations approximated the 48- and 72-h LC sub 50s for pink shrimp (0.22 micrograms/L and 0.15 micrograms/L) and mysids (0.37 micrograms/L and 0.18 micrograms/L). All exposure concentrations were three orders of magnitude below the 24-h LC sub 50. The responses of caged pink shrimp and mysids exposed to slowly changing concentrations of fenthion in the field were similar to what would have been predicted based on laboratory tests that established 24-, 48-, and 72-h LC sub 50s. (See also W89-01892) (Lantz-PTT)
W89-01905

EVALUATING RISKS OF GENETICALLY ENGINEERED PRODUCTS UNDER THE TOXIC SUBSTANCES CONTROL ACT,
Environmental Protection Agency, Washington, DC. Office of Pesticides and Toxic Substances.
A. Hollander, and J. Rissler.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 179-191, 7 ref.

Descriptors: *Genetic pollution, *Management planning, *Genetics, *Toxic Substances Control Act, *Risk assessment, *Water pollution effects, Regulations, Aquatic toxicology.

The Office of Toxic Substances' has created a plan for evaluating the risks of genetically engineered organisms subject to the Toxic Substances Control Act. The events in the risk assessment process, the categories of information needed for the assessment, and underlying principles are identified and discussed. Major features of the plans are: (1) the overall components of the review, such as hazard, exposure, and benefit assessment, are analogous to those for conventional products; (2) despite the lack of standardized risk assessment techniques, sufficient information exists to conduct case-by-case reviews; (3) until standardized techniques are developed, each product will be subject to a detailed review on a case-by-case basis; (4) data needs will be flexible and will depend upon the characteristics of the particular product under review; (5) due to the interdependence of information, tradeoffs can be made; (6) prenotice consultations will significantly expedite the review process; and (7) different combinations of nonagency experts will assist in each product assessment. (See also W89-01892) (Author's abstract)
W89-01906

ASSESSMENT OF EXPOSURE MODELS FOR BIOENGINEERED MICROORGANISMS,
Battelle Columbus Div., OH. Environmental Physics and Chemistry Section.
L. B. Goss, B. W. Cornaby, K. M. Duke, N. G. Reichenbach, and P. R. Sticksel.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 192-206, 2 fig, 5 tab, 34 ref.

Descriptors: *Genetic pollution, *Environmental effects, *Risk assessment, *Model studies, *Bioengineering, Biological studies, Mathematical models, Aquatic toxicology, Population exposure.

Environmental risk assessment performed for chemicals involves exposure assessment, effects assessment, and risk integration. The nature of living microorganisms (growth, replication, and survival), as compared to chemicals, requires that their biological attributes be integrated into risk assessment. A study to assess the state of the art of exposure models for organisms and microorganisms in air, soil, and water was undertaken. Mathematical models developed during the past 15 years were organized into three categories: organism population dynamics, source features and transport, and management and control. One hundred forty-eight models were examined, and 56 were judged to have potential as exposure models. These 56 were screened to 31 models that were evaluated against eight components that the ideal biotechnology model should have: (a) five state/process components (organism population, source application, exposure site, movement, and imposed management); and (b) three software components (use friendliness, availability/implementability, and flexibility). Each model was rated by individual components, combinations of two components, and total state/process components. An ideal exposure assessment model with high scores in all components was not found. Combining one or more models so that the strong components of one compensate for the weak components of another was concluded to be the best approach for obtaining a predictive model for microorganisms. Potential couplings were ascertained from among the 31 models. Most of these couplings would combine an organism population dynamics model with a model from the U.S. EPA's Graphical Exposure Modeling System (source and transport oriented models). (See also W89-01892) (Lantz-PTT)
W89-01907

FACTORS AFFECTING THE ACCEPTANCE AND REJECTION OF GENETICALLY ALTERED MICROORGANISMS BY ESTABLISHED NATURAL AQUATIC COMMUNITIES,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W89-01908

EVIDENCE FOR GENETIC MODIFICATION OF MICROORGANISM OCCURRING IN NATURAL AQUATIC ENVIRONMENTS,
Maryland Univ., College Park. Dept. of Microbiology.
R. R. Colwell, and D. J. Grimes.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 222-230, 5 tab, 16 ref. NSF Grant BSR-84-01397, NOAA Grant NA79AA-D-00062, and EPA Contract CR812246-01-0.

Descriptors: *Toxicology, *Population exposure, *Aquatic toxicology, *Genetics, *Water pollution effects, *Ecological effects, Biological studies, Ocean dumping, Waste disposal, Wastewater, Bacteria, Plasmids, Genetic engineering.

Recent work at a deep ocean dump site off the coast of Puerto Rico has shown that changes in the microbial populations of the receiving waters can be detected, that is, changes in bacterial community structure, over and above seasonal effects, have been documented. Microbial impact of the dumping of wastes occurs at three levels that can be measured. These include the initial effects at the time of dumping, followed by sustained community structural changes, and finally, genetic modification of the natural population evidenced by increased incidence of plasmids. The ocean dumping studies were augmented by examination of the incidence of plasmids in bacteria isolated from samples collected at other locations in the Atlantic Ocean, including outfall samples collected at Barceloneta, Puerto Rico, off shore samples collected at an outfall off Ocean City, MD, and a clean unpolluted site. The incidence of plasmids could be significantly and dramatically related to influx of sewage. Thus, environmental changes already occur as a result of entrance of allochthonous material into the marine environment. It is clear that baseline measurements are necessary to determine genetic alteration already taking place, before effects of entry of genetically engineered organisms to the marine environment can be determined. (See also W89-01892) (Author's abstract)
W89-01909

METABOLISM OF BENZO(A)PYRENE BY A MIXED FUNCTION OF OXYGENASE SYSTEM IN BLUE CRABS, CALLINECTES SAPIDUS,
Skidaway Inst. of Oceanography, Savannah, GA.
R. F. Lee.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 233-240, 1 fig, 1 tab, 26 ref. NSF Grant OCE-8017893.

Descriptors: *Toxicology, *Benzo(a)pyrene, *Crabs, *Water pollution effects, *Fate of pollutants, *Aquatic toxicology, Bioaccumulation, Organic compounds, Metabolism, Biotransformation.

Benzo(a)pyrene was metabolized by the stomach and hepatopancreas of blue crabs (Callinectes sapidus). Microsomes from the stomach showed high aryl hydrocarbon hydroxylase (AHH) activity while those from the hepatopancreas showed low AHH activity, due to release of an AHH inhibitor during tissue extraction. Stomach microsomes, metabolized 14-C-benzo(a)pyrene to a series of dihydrodiols, phenols, and quinones, including 9, 10-, 4, 5-, and 7, 8-dihydrodiol benzo(a) pyrene, 9-hydroxybenzo(a)pyrene, 3-hydroxybenzo(a)pyrene, and quinones. The major metabolite was 3-hydroxybenzo(a)pyrene. Cytochrome P-450, one of the components of the AHH system, was found in microsomes of both stomach and hepatopancreas. The cell types found in the hepatopancreas were isolated and separated. Cytochrome P-450 was found in a mixture of F- and B-cells but was absent in R-cells. The F- and B-cells are though to function in protein synthesis and enzyme secretion. One major and two minor forms of cytochrome P-450 were partially purified from blue crab hepatopancreas microsomes. The major form in a reconstituted enzyme system was active in oxidizing benzo(a)pyrene to a series of phenols and diols. (See also W89-01892) (Author's abstract)
W89-01910

BIOTRANSFORMATION OF BENZO(A)PYRENE BY MERCENARIA MERCENARIA AND CRASSOSTREA VIRGINICA,
Sloan-Kettering Inst. for Cancer Research, New York.
R. S. Anderson, and M. A. Angel.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 241-251, 2 fig, 3 tab, 39 ref. EPA Contract CR807740.

Descriptors: *Toxicology, *Biotransformation, *Fate of pollutants, *Benzo(a)pyrene, *Clams,

*Oysters, *Aquatic toxicology, *Water pollution effects, Metabolism, Radioassays, Aroclor, Biological studies, Organic compounds, Mollusks, Enzymes.

Using a sensitive, radioisotopic assay for aryl hydrocarbon hydroxylase (AHH), a comparatively low level of benzo(a)pyrene (B(a)P) metabolism was routinely measured in digestive gland homogenates. Attempts to induce overall BaP metabolism by exposure to Aroclor 1254, an inducer of mammalian AHH, were largely unsuccessful. However, Aroclor treatment produced an altered B(a)P metabolite profile for each bivalve species tested. The metabolites were separated and identified by coelution with authentic standards, using high-performance liquid chromatography. Untreated mollusks produced several dihydrodiols and phenolic derivatives; Aroclor treatment usually resulted in augmented generation of 9,10-, 4,5-, and 7,8-diols, as well as production of quinones and atypical monohydroxylated metabolites. The data suggest that BaP biotransformation by bivalve enzyme systems can yield both potentially carcinogenic (BaP 7,8-diol) and detoxified metabolites. However, no apparent activation of BaP by molluscan enzymes was seen using the Ames Salmonella tester strains. (See also W89-01892) (Author's abstract)
W89-01911

ASSESSMENT OF WATER CONTAMINATION BY CHLOROPHENOLICS AND RESIN ACIDS WITH THE AID OF FISH BILE METABOLITES,
Joensuu Univ. (Finland). Dept. of Biology.
A. Oikari, and B. Holmbom.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 252-267, 7 fig, 31 ref. The Academy of Finland/Research Council for the Environmental Sciences (06/085).

Descriptors: *Toxicology, *Path of pollutants, *Bioassay, *Fate of pollutants, *Water pollution effects, *Chlorophenols, *Resin acids, *Bile, *Aquatic toxicology, Metabolism, Fish physiology, Kraft mills, Rainbow trout, Pulp and paper industry, Industrial wastes.

For a better understanding of relationships between toxicants of bleached kraft pulp mill effluents (BKME) and their predicted biological effects, the metabolic fate and hepatic excretion of chlorphenolics and resin acids in fishes were investigated. Three types of short-term experiments were conducted with rainbow trout: controlled laboratory exposures, semi-controlled field laboratory exposures, and caging experiments in water receiving BKME. Additionally, samples were collected from feral fish populations exposed to BKME at various distances from the source. Only a small proportion (<0.5 to 5%) of all chlorophenolics and resin acids was excreted to the bile as free substances. About 95% of bile resin acid conjugates were glucuronides. Most of the conjugates in trout exposed to chlorophenols were glucuronides, a small proportion of them being sulfates. A good relationship between the dilution of BKME and the total amount of bile conjugates of chlorophenolics and resin acids was observed even in semi-controlled experiments. Both the caging exposures of trout and the field material collected from the recipient revealed consistent results between the concentrations of conjugates and the distance from the BKME source. The authors suggest that useful information about the chronic loading of fish populations by toxic substances in BKME can be achieved through analyses of the total concentrations of their bile conjugates. (See also W89-01892) (Author's abstract)
W89-01912

BIOCONCENTRATION, DETOXIFICATION, AND EXCRETION OF MUTAGENIC RIVER POLLUTANTS IN FISH BILE,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. of Mutagenesis and Carcinogenesis.
For primary bibliographic entry see Field 5B.
W89-01913

PASSIVE PERCHORIONIC CARCINOGEN BIOASSAY USING RAINBOW TROUT (SALMO GAIRDNERI) EMBRYOS,
Roswell Park Memorial Inst., Buffalo, NY. Dept. of Experimental Biology.
For primary bibliographic entry see Field 5A.
W89-01914

INFLUENCE OF AGE ON PATTERNS OF UPTAKE AND EXCRETION OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE RAINBOW TROUT EMBRYO,
Washington Univ., Seattle. School of Medicine.
For primary bibliographic entry see Field 5B.
W89-01915

EFFECT OF DIET ON COPPER TOXICITY TO NEANTHES ARENACEODENTATA (ANNELIDA: POLYCHAETA),
Environmental Research Lab., Narragansett, RI.
C. E. Pesch, P. S. Schauer, and M. A. Balboni.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 369-383, 1 fig, 4 tab, 25 ref. EPA Contract 806735.

Descriptors: *Toxicology, *Water pollution effects, *Aquatic toxicology, *Copper, *Bioassay, Polycheates, Lethal limits, Microbiological studies, Bioaccumulation, Toxicity, Diets, Food chains.

Groups of Neanthes arenaceodentata were fed different diets for four weeks then exposed to copper in seawater to determine if nutritional history would affect copper toxicity. Two experiments were conducted in which mortality was the endpoint. In the first experiment, the 28-day LC sub 50 concentrations were > 98 micrograms copper (Cu)/L for polychaetes fed a combination diet of cultured fresh Ectocarpus siliculosus and TetraMarin, 80 micrograms Cu/L for those fed field-collected dried Enteromorpha clathrata (fed rehydrated), and 38 micrograms Cu/L for those fed cultured fresh Enteromorpha clathrata. The greater sensitivity of worms fed the fresh E. clathrata may have resulted because the fresh E. clathrata accumulated copper while in the experimental system, therefore, worms fed this diet were probably also exposed to copper through the food. Metal analysis of the food revealed that the mean copper concentration of fresh E. clathrata was five to six times higher than the mean copper concentration of dried E. clathrata of TetraMarin after 48 h in any of the copper-dosed treatments. Mean copper concentration of the fresh E. siliculosus was three to five times higher than dried E. clathrata of TetraMarin after 48 h in the experimental system. In the second experiment, diet had an effect on the short-term results (4 to 10-day Lc sub 50 values), but not the long-term results (28-day LC sub 50 values). Worms fed prawn flakes were significantly more resistant to copper than worms fed dried E. clathrata; the 10-day LC sub 50 values were 246 and 124 micrograms Cu/L, respectively. The 28-day Lc sub 50 values for these two diets were not significantly different (83 and 86 micrograms Cu/L). The short-term LC sub 50 values in Experiment 2 (where diet-toxicant interaction was minimized) differed by < a factor of 2, which is within the range of variability (1.18 to 3.31) in an interlaboratory comparison with this species. (See also W89-01892) (Lantz-PTT)
W89-01920

QUALITY ASSURANCE REVIEW OF THE USE OF THE HYDRA ASSAY IN DEVELOPMENTAL TOXICITY (TERATOLOGY) STUDIES,
Argus Research Labs., Inc., Horsham, PA.
J. E. Goeke, and P. D. Ference.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 384-389, 11 ref.

Descriptors: *Quality control, *Water pollution effects, *Bioassay, *Toxicolgy, *Hydra, *Aquatic toxicology, Toxicity, Embryos.

It is the purpose of this paper to: (1) descrive the nature and conduct of the Hydra Assay, and (2) offer a procedure for assuring and documenting its quality. The Hydra Developmental Toxicity Assay provides a rapid and reliable prescreening system for teratogenic hazard. Fresh water Hydra attenuata polyps are dissociated into component cells that can be randomly reaggregated into an 'artificial embryo' that will produce new adult polyps in approximately one week. During this whole-body regeneration, the artificial embryo achieves most of the developmental phenomena required during mammalian organogenesis. By determining the minimal affective concentration (MAC) of the substance, both for adult Hydra and embryos, it is possible to determine the substance's ability to disrupt development phenomena (developmental toxicity) and determine an A/D ration, the same ratio as that obtained through the use of mammalian test systems. The A/D ratio is calculated on the basis of the adult (A) and the developmental (D) minimal affective concentrations. An A/D ratio near unity indicates that the substance tested can disrupt development only at doses that also produce overt adult toxicity, and that it constitutes no unique hazard to the conceptus. An A/D ratio of 10.0 or more generally indicates that the substance tested represents a unique hazard to the conceptus, although the concentrations of the test substance required to produce this ratio may bear no direct relationship to the concentrations needed to achieve the same results in mammals. The phases of the Hydra Assay that are deemed 'critical', and that therefore require audit or inspection, or both, include: (1) protocol review; (2) preparation of media; (3) preparation of the test substance concentrations; (4) preparation of adult and embryo Hydra for use; (5) examination and evaluation of Hydra specimens at periodic intervals; (6) test substance administration; (7) documentation of the environmental conditions and maintenance of the Hydra farm; and (8) report and raw data audit. (See also W89-01892) (Author's abstract)
W89-01921

BEHAVIORAL AND MORPHOLOGICAL CHANGES IN FATHEAD MINNOW (PIMEPHALES PROMELAS) AS DIAGNOSTIC ENDPOINTS FOR SCREENING CHEMICALS ACCORDING TO MODE OF ACTION,
Environmental Research Lab.-Duluth, MN.
R. A. Drummond, C. L. Russom, D. L. Geiger, and D. L. DeFoe.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 415-435, 1 fig, 6 tab, 48 ref.

Descriptors: *Fathead minnows, *Morphology, *Aquatic toxicology, *Water pollution effects, *Pollutant identification, *Toxicology, *Lake Superior, *Bioassay, Stress, Fish behavior.

Acute (96-h) toxicity tests were conducted using 30-day old fathead minnows (Pimephales promelas). A total of 139 chemicals were tested under flow-through conditions at a temperature of 25 + or - 1.0 C using Lake Superior water. A checklist was developed for systematically recording visual observations of behavioral and morphological changes. The checklist contained 40 different code items representing 10 general categories such as locomotor activity, morphological anomalies, etc. Loss of schooling behavior appeared to be the most sensitive indicator of general stress and was observed with 96% of the tested chemicals. Although deviate changes in behavior were found to be sensitive indicators of stress, they cannot be used solely to classify chemicals according to mode of action. Gross morphological changes are equally important. Development of a model, based on combinations of behavioral and morphological

data, appears possible for screening and differentiating chemicals according to toxic action. (See also W89-01892) (Author's abstract)
W89-01924

EFFECTS OF DIET QUANTITY ON SHEEPSHEAD MINNOWS (CYPRINODON VARIEGATUS) DURING EARLY LIFE-STAGE EXPOSURES TO CHLORPYRIFOS,
Environmental Research Lab., Gulf Breeze, FL.
G. M. Cripe, D. J. Hansen, S. F. Macauley, and J. Forester.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 450-460, 4 tab, 22 ref.

Descriptors: *Diet, *Minnows, *Aquatic toxicology, *Bioassay, *Toxicology, *Chlorpyrifos, Toxicity, Water pollution effects, Metabolism.

The influence of food quantity on the effects of chlorpyrifos was determined in early life-stage (ELS) toxicity tests with estuarine sheepshead minnows (Cyprinodon variegatus). Three 28-day ELS tests were conducted simultaneously, each with a different feeding rate: approximately 20, 110, or 550 Artemia nauplii/fish per feeding. In the first group of three tests, growth was reduced significantly ($p <$ or $= 0.001$) at nearly all feeding rates and chlorpyrifos concentrations tested (3.1 to 52 micrograms/L). Therefore, a second group of three tests was conducted at lower chlorpyrifos concentrations (0.4 to 6.8 micrograms/L) and the same feeding rates used in the first series. Chlorpyrifos concentrations that significantly decreased fish growth were $>$ or $=$ to 3.0 micrograms/L, regardless of feeding rate. Weights of fish at the end of all tests were directly associated with concentration and food. Fish receiving the greatest amount of food weighed 10 times more than those receiving the least and were three times heavier than those in the intermediate feeding rate. In treatments where growth was affected, mean percentage survival ranged from 67% at 52 micrograms/L to 99% at 3.0 micrograms/L. The standard deviations for this survival varied from 14 at the lowest feeding rate for fish exposed to 52 micrograms/L to 2.8 for fish fed 550 Artemia per cup in 3.0 micrograms/L. Bioconcentration factors (amount of chlorpyrifos in tissue/average measured water concentrations) and chlorpyrifos in whole fish at exposure concentrations $>$ or $=$ to 3.0 micrograms/L generally increased with increased feeding rates and increased chlorpyrifos concentrations. Within the feeding range tested, the quantity of available food was not an important factor controlling differences in growth of Cyprinodon variegatus exposed to chlorpyrifos. However, when food quantity restricted growth, survival of sheepshead minnows was not as reproducible, and variability (standard deviation) increased with decreased food. (See also W89-01892) (Author's abstract)
W89-01926

METHODOLOGY FOR DETERMINING THE RELATIONSHIP BETWEEN TOXICITY AND THE AQUEOUS SPECIATION OF A METAL,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5A.
W89-01927

COMPARISON OF LABORATORY AND FIELD METHODS FOR TESTING THE TOXICITY OF CHEMICALS SORBED TO SEDIMENTS,
Monsanto Environmental Sciences Center, St. Louis, MO.
For primary bibliographic entry see Field 5A.
W89-01929

AQUATIC TOXICOLOGY AND HAZARD ASSESSMENT: SEVENTH SYMPOSIUM,
American Society for Testing and Materials, Philadelphia, PA.
A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. 587p. Edited by Rick D. Cardwell, Rich Purdy, and Rita Comotto Bahner.

Descriptors: *Water pollution effects, *Symposium, *Aquatic toxicology, *Toxicology, *Environmental effects, *Bioassay, *Ecological effects, Daphnia, Sediment contamination, Wastewater disposal, Aquatic environment, Toxicity.

The symposium was divided into five sections. The first addresses the area of foremost ASTM emphasis, methods development and validation. Results of single-species tests are presented; the greatest emphasis is on several species of daphnids (class Crustacea, order Cladocera), the main toxicological invertebrate test species in freshwater. The remaining four sessions implicitly or explicitly address the theme of ecological relevance. There is much research interest concerning the potential toxicity of chemicals that are bound to particulates, whether natural particulates (e.g., detritus and clay), sewage sludge, or wastewaters. This area has traditionally received much less emphasis than aquatic hazard assessments of dissolved chemicals in the water column. The section on Evaluation of Chemicals and Chemical Wastes consists of papers addressing this area in terms of methods for assessing and interpreting toxicity and hazard evaluation data. The third section, Assessing Impacts of Wastes on Aquatic Ecosystems, addresses the complex issue of whether effects of chemicals and chemical wastes, determined by laboratory testing, can be predicted or in fact occur in the environment. The issue is addressed from several vantage points, which will provide the reader a perspective on the issue's complexity. Why chemicals, wastes, and sediments do or do not kill or undergo assimilation by aquatic life is the subject of the section on bioavailability. (See W89-01931 thru W89-01967) (Lantz-PTT)
W89-01930

EVALUATION OF FILAMENTOUS ALGAE AS BIOMONITORS OF METAL ACCUMULATION IN SOFTWATER LAKES: A MULTIVARIATE APPROACH,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 5A.
W89-01931

CYANOPHAGE ASSAY AS A NEW CONCEPT IN THE STUDY OF ENVIRONMENTAL TOXICITY,
Algal Research Center, Landenberg, PA.
For primary bibliographic entry see Field 5A.
W89-01932

DIETS FOR CERIODAPHNIA RETICULATA LIFE-CYCLE TESTS,
Environmental Research Lab.-Duluth, MN.
For primary bibliographic entry see Field 5A.
W89-01933

EFFECT OF DIET ON THE SENSITIVITY OF DAPHNIA MAGNA TO LINEAR ALKYLBENZENE SULFONATE,
Procter and Gamble Co., Cincinnati, OH. Ivorydale Technical Center.
For primary bibliographic entry see Field 5A.
W89-01934

STUDY OF THE RELIABILITY OF DAPHNIA ACUTE TOXICITY TESTS,
Environmental Monitoring and Support Lab.-Cincinnati, OH. Biological Methods Branch.
For primary bibliographic entry see Field 5A.
W89-01935

SHORT-CUT CHRONIC TOXICITY ESTIMATES USING DAPHNIA MAGNA,
Monsanto Co., St. Louis, MO.
For primary bibliographic entry see Field 5A.
W89-01936

NEW AQUATIC BIOASSAY TECHNIQUE USING WYEOMYIA SMITHII, THE PITCHER-PLANT MOSQUITO,
Air Force Occupational and Environmental Health Lab., Brooks AFB, TX.
For primary bibliographic entry see Field 5A.
W89-01937

EFFECTS OF SMALL FISH PREDATION ON MICROCOSM COMMUNITY BIOASSAY,
Washington Univ., Seattle. Coll. of Ocean and Fishery Sciences.
For primary bibliographic entry see Field 5A.
W89-01938

FACTORS AFFECTING GROWTH AND SURVIVAL OF THE ASIATIC CLAM, CORBICULA SP., UNDER CONTROLLED LABORATORY CONDITIONS,
Battelle Pacific Northwest Labs., Richland, WA.
D. D. Dauble, D. S. Daly, and C. S. Abernethy.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 134-144, 2 fig, 3 tab, 22 ref. DOE Contract No. DE-AC06-76RL0 1830.

Descriptors: *Growth, *Clams, *Water pollution effects, *Toxicology, *Bioassay, *Aquatic toxicology, Food, Water temperature, Toxicity, Phytoplankton, Multivariate analysis, Mortality.

Growth of Asiatic clams (Corbicula sp.) was determined in relation to food supply, water temperature, and clam size as an aid to researchers conducting chronic effects toxicity studies. Mean initial sizes (shell length) of clam groups were small (12 mm), medium (20 mm), and large (28 mm). Water temperatures for the two 84-day test series were 10, 20, and 30 C. Linear models provided good relationships (r-squared $>$ 0.90) between clam shell length, total weight, and wet/dry tissue weights. Clam growth was minimal during low phytoplankton densities (approximately 300 cells/ml), and all three size groups lost weight at 20 and 30 C. Mortality of small clams at 30 C was 100% after 71 days. At phytoplankton densities $>$ 1000 cells/ml, overall differences in growth with respect to clam size and temperature were detectable at $p > 0.01$; growth of all clam groups was greatest at 30 C. Small clams exhibited the greatest absolute increase in mean shell length at all test temperatures and their weight gains were similar to those of medium and large clams. Clams in well water that were fed trout chow at 117 mg/ml dry weight had an estimated conversion efficiency of 2.0%. Use of individual marks and multivariate analysis techniques decreased sample size and test duration needed to detect differences in Corbicula growth. (See also W89-01930) (Author's abstract)
W89-01939

METHOD FOR EARLY LIFE-STAGE TOXICITY TESTS USING THREE ATHERINID FISHES AND RESULTS WITH CHLORPYRIFOS,
Environmental Research Lab., Gulf Breeze, FL.
L. R. Goodman, D. J. Hansen, D. P. Middaugh, G. M. Cripe, and J. C. Moore.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 145-154, 3 tab, 21 ref.

Descriptors: *Bioassay, *Fish, *Chlorpyrifos, *Aquatic toxicology, *Toxicology, Toxicity, Ecological effects, Insecticides, Mortality, Lethal limits, Embryos, Bioaccumulation.

Methods for obtaining embryos and conducting early life-stage toxicity tests (continuous exposure from the embryonic stage to approximately three weeks or more into the exogenous feeding stage) with three estuarine species of atherinid fishes, were developed. Early life-stage tests were conducted for 28 days with Menidia beryllina, M. menidia, and M. peninsulae and the insecticide chlorpyrifos. Responses of the three species were similar: upper chronic values ('effect' concentrations) ranged from 0.48 to 1.8 micrograms chlorpyrifos/L and lower chronic values ('no effect' concentrations) ranged from 0.28 to 0.75 micrograms/L. Chlorpyrifos exposure did not affect survival of embryos to hatching which averaged 91 to 93% for each species. In treatments in which no adverse effects were observed, combined survival of M. menidia embryos and hatched fish averaged 51% and fish weights averaged 23 mg; for M. peninsulae, 69% and 13.6; and for M. beryllina, 81% and 8.7 mg. Chlorpyrifos bioconcentration factors (concentration in whole fish/average measured concentration in water) averaged 220 for M. beryllina, 460 for M. peninsulae, and probably < 420 for M. menidia. From these three species, toxicologists may select an Atlantic or Gulf Coast species that occurs in either high or low salinity. (See also W89-01930) (Authors's abstract)
W89-01940

USE OF BIOCHEMICAL MEASUREMENTS TO DETECT POLLUTANT-MEDIATED DAMAGE TO FISH,
Battelle New England Marine Research Lab., Duxbury, MA.
J. M. Neff.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 155-183, 6 tab, 174 ref.

Descriptors: *Biochemical analysis, *Water pollution effects, *Fish, *Bioassay, *Toxicology, *Aquatic toxicology, Enzymes, Tissue analysis, Stress, Metallothionein.

The use of enzyme activity or concentration of biochemicals in the tissues to detect pollutant stress in fish is reviewed. Of the many biochemical parameters which have been measured, most are of limited value at present, primarily because correlations between biochemical effects and significant deleterious effects in the fish population have not been established. Characteristics of the metallothionein and mixed-function oxygenase systems and activity of acetylcholinesterase and delta amino levulinic acid dehydratase in fish tissues or blood may be useful for identifying fish which have been exposed to particular classes of pollutants. Some blood enzymes and biochemicals are useful for diagnosing liver damage in fish. Biochemical composition and concentrations in the blood and tissues of fish from polluted habitats differ in characteristic ways from those of fish of the same species from nearby clean areas. Some of these differences show promise for use in assessing damage to fish populations. (See also W89-01930) (Author's abstract)
W89-01941

EFFECT OF IRON AND ZINC INTERACTION ON ALGAL COMMUNITIES,
Illinois State Water Survey, Peoria. Water Quality Section.
W. Wang.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 187-201, 11 fig, 5 tab, 17 ref.

Descriptors: *Iron, *Zinc, *Algae, *Ecological effects, *Toxicology, *Aquatic toxicology, *Water pollution effects, Toxicity, Growth, Heavy metals.

The objective of this study was to determine the effect of iron and zinc interaction on algal communities. Algal samples from three sources were used: Peoria, Farmington, and Princeton, all in Illinois. In general, it was found that zinc is much more toxicity than iron. In the case of Peoria samples, the effect of iron and zinc interaction was noninteractive in one case and antagonistic in another. In the case of the Farmington samples, these two metals are noninteractive against algal growth. To the Princeton samples, iron and zinc are synergistic. (See also W89-01930) (Author's abstract)
W89-01942

COMPARISON OF SYSTEM DESIGN AND REPRODUCIBILITY TO ESTIMATE BIOCONCENTRATION OF DI-N-HEXYLPHTHALATE BY DAPHNIA MAGNA,
New York Cooperative Fishery Research Unit, Ithaca, NY.
For primary bibliographic entry see Field 5A.
W89-01943

SEDIMENT MICROBIAL ACTIVITY TESTS FOR THE DETECTION OF TOXICANT IMPACTS,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
For primary bibliographic entry see Field 5A.
W89-01944

COMPARATIVE TOXICITY OF WHOLE AND LIQUID PHASE SEWAGE SLUDGES TO MARINE ORGANISMS,
EA Engineering, Science, and Technology, Inc., Sparks, MD.
J. A. Fava, J. J. Gift, A. F. Maciorowski, W. L. McCulloch, and H. J. Reisinger.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 229-252, 3 fig, 4 tab, 21 ref.

Descriptors: *Toxicity, *Sludge, *Wastewater disposal, *Marine environment, *Toxicology, *Water pollution effects, *Aquatic toxicology, Municipal wastewater, Suspended solids, Silversides, Shrimp, Mysids, Ammonia.

The chemical composition and acute toxicity of whole digested municipal sewage sludges from twelve water pollution control plants were collected, fractionated, and analyzed. The chemical composition and acute toxicity of whole sewage sludges were compared with those of liquid sewage sludge phases. The chemical constituents analyzed included nutrients, conventional parameters, and U.S. Environmental Protection Agency consent decree priority pollutants. Results indicated that most toxic constituents were associated with suspended solids and were therefore dramatically reduced in the liquid phase sludge fractions. Despite the dramatic reduction of metals, pesticides, and other organic compounds in the liquid sludge phases, there was a distinct trend towards equivalent phase toxicity to Atlantic silversides (Menidia menidia) and grass shrimp (Palaemonetes pugio). However, whole sludges were generally more toxic to mysids (Mysidopsis bahia) than were the liquid phase sludges. Evidence to support the hypothesis that ammonia may be the major contributor to overall toxicity of the sewage sludges tested is presented and discussed. (See also W89-01930) (Author's abstract)
W89-01945

APPROACH TO SEWAGE SLUDGE BIOACCUMULATION POTENTIAL TESTS,
Ecological Analysts, Inc., Sparks, MD.
A. F. Maciorowski, W. L. McCulloch, and J. A. Fava.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 253-268, 6 tab, 14 ref.

Descriptors: *Bioaccumulation, *Sludge, *Wastewater disposal, *Water pollution effects, *Aquatic toxicology, *Pollutant identification, *Toxicology, Clams, Shrimp, Silversides, Cadmium, Mercury, Polychlorinated biphenyls, DDT, Hydrocarbons, Toxicity, Tissue analysis.

A sewage sludge bioaccumulation potential test responsive to the EPA's Ocean Dumping Regulations and Criteria was developed and evaluated with sludges from twelve water pollution control plants with secondary treatment. In keeping with the regulations, the test was designed to examine if hard clams, grass shrimp, and Atlantic silversides exposed to sludge exhibited statistically elevated body burdens of cadmium, mercury, PCB, DDT and metabolites, and petroleum hydrocarbons compared against controls. Exposure consisted of ten-day renewal followed by a two-day post-exposure period in clean seawater. Five replicate aquaria per treatment per species were employed using sludge concentrations of 0.033, 0.0084, and 0.0042%. Seven hundred and eighty tissue samples were analyzed for the specified chemicals. Of 195 possible statistical evaluations (13 sludges X 3 species X 5 chemicals), significant differences between treatment group means occurred in only 31 trials. However, in 27 of these trials, the highest body burden mean was: (1) at or below pretest levels for the organisms tested; (2) within the concentration range exhibited by control groups over the study period, or (3) present in controls. The inherent limitations of basing pass/fail compliance of ocean-dumped material on a single timepoint exposure are discussed. (See also W89-01930) (Author's abstract)
W89-01946

METHOD OF ASSESSING THE TOXICITY OF CONTAMINATED FRESHWATER SEDIMENTS,
EG and G Bionomics, Wareham, MA. Aquatic Toxicology Lab.
For primary bibliographic entry see Field 5A.
W89-01947

PHOXOCEPHALID AMPHIPOD BIOASSAY FOR MARINE SEDIMENT TOXICITY,
Environmental Research Lab.-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center.
For primary bibliographic entry see Field 5A.
W89-01948

OVERVIEW OF BIOLOGICAL EFFECTS TESTING IN PUGET SOUND, WASHINGTON: METHODS, RESULTS, AND IMPLICATIONS,
E.V.S. Consultants Ltd., North Vancouver (British Columbia).
P. M. Chapman, R. N. Dexter, R. M. Kocan, and E. R. Long.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 344-363, 5 fig, 2 tab, 50 ref. NOAA Contract 81 RAC00139.

Descriptors: *Toxicology, *Water pollution effects, *Puget Sound, *Washington, *Aquatic toxicology, Lethal limits, Fish, Oligochaetes, Amphipods, Toxicity, Mortality, Eggs, Larvae, Smelt, Population dynamics, Sediment contamination.

There are relatively few broad-scale studies in which the toxicity (including mutagenicity) of complex contaminant mixtures found in the marine environment has been directly tested. The authors recently completed a series of biological effects studies in Puget Sound, Washington, which involved testing the toxicity of sediment from a variety of sites including heavily industrialized embayments and reference and control areas. Areas chosen for testing encompassed gradients of chemical contamination ranging from lightly to heavily impacted. The following tests were done: (1) acute lethality to a marine fish species (stickleback) and

two invertebrate species (an oligochaete and an amphipod); (2) sublethal effects on the respiration rate of an oligochaete species; (3) effects on mitosis of fish cells in culture; (4) lethal and sublethal effects on oyster larvae; (5) lethal and sublethal effects on surf smelt eggs and larvae; (6) lethal and sublethal effects on a polychaete's life-cycle; and (7) in vitro fish cell reproduction studies. Up to 97 sites were investigated, and one or more tests were applied to sediments from each site. The results indicated that sediment collected from areas shown by other studies to be contaminated with a variety of toxic chemicals were capable of causing lethal and sublethal effects to tested biota in the laboratory. There was good correspondence among the results of the different tests. Sediments from badly contaminated areas overall were the most toxic, while those from the least contaminated areas were the least toxic. Data from field and laboratory studies performed by others with fish and benthos supported the geographic trends observed here. (See also W89-01930) (Lantz-PTT)
W89-01952

USING THE NATURAL DETOXIFICATION CAPACITIES OF MARINE ORGANISMS TO ASSESS ASSIMILATIVE CAPACITY,
Southern California Coastal Water Research Project Authority, Long Beach.
For primary bibliographic entry see Field 5B.
W89-01953

IMPLICATIONS OF WASTE DISPOSAL IN COASTAL WATERS ON FISH POPULATIONS,
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
F. A. Cross, D. S. Peters, and W. E. Schaaf.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 383-399, 9 fig, 1 tab, 40 ref.

Descriptors: *Toxicology, *Aquatic toxicology, *Waste disposal, *Water pollution effects, *Fish, *Coastal waters, Waste management, Estuaries, Sludge, Wastewater disposal, Simulation analysis, Model studies.

Assessment and prediction of the impact of pollution on animal populations are required to improve waste management strategies. Use of information on commercial fishery populations in impact assessment is advised for three reasons: (1) pollution-related effects on marine fishery populations will have direct economic consequences, (2) many major fish stocks that already are overfished should be more vulnerable to additional stresses than nonexploited populations, and (3) long-term data bases that reflect population changes are available. The Atlantic menhaden, Brevoortia tyrannus, an economically and ecologically important fish, inhabits coastal and estuarine waters along the mid-Atlantic coast of the United States. Within its range, a number of man-related activities have been identified that could potentially affect its population size. Adverse impacts in coastal waters could result from an increase in the ocean dumping of sewage sludge and industrial wastes and oil spilled during the development of offshore oil reserves. In estuaries, adverse impacts could result from a slow but steady decline in water quality associated with human population growth and industrialization of coastal areas. Scenarios were developed using a density-independent Leslie matrix model and data from the Atlantic menhaden fishery to simulate population responses to both catastrophic and chronic mortalities. These simulations demonstrate that a fish population which is heavily fished may have limited compensatory reserve and thus may be particularly sensitive to pollution. To improve predictive capacity, the effects of pollution on fisheries requires an understanding of the environmental factors that control variability in fish populations and the effect of multiple stresses on these stocks over their entire geographical range. Increased predictive capability can be gained most cost-effectively through closer integration of the disciplines of population dynamics and toxicology. (See also W89-01930) (Author's abstract)
W89-01954

EXTRAPOLATING FROM THE LABORATORY TO THE FIELD: HOW UNCERTAIN ARE YOU,
Oak Ridge National Lab., TN. Environmental Sciences Div.
G. W. Suter, L. W. Barnthouse, J. E. Breck, R. H. Gardner, and R. V. O'Neill.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 400-413, 8 fig, 20 ref. EPA Contract 40-740-78 and DOE Contract W-7405-eng-26.

Descriptors: *Toxicology, *Water pollution effects, *Data interpretation, *Aquatic toxicology, Lethal limits, Fish, Toxicity, Population dynamics, Ecological effects, Hazard assessment.

A methodology for assessing toxic effects of chemicals on fish should be able to begin with an emission rate, an LC sub 50, and a description of the receiving system and generate an estimate of the likelihood of reductions in fish populations. This process is a series of extrapolations, each with an associated variance. The LC sub 50 must be extrapolated from the test species to the species of interest, to life-cycle toxicity, to long-term toxiicty in the field, to changes in population size due to direct toxic effects and, finally, to the combined direct and indirect toxic effects. Similarly, the emission rate must be converted into an effective environmental concentration in an imperfectly known hydrologic, chemical, physical, and biological system. Summarized are some data and methods for making these extrapolations (taxonomic 4 extrapolation, acute/chronic extrapolation, direct toxicity to individuals in the field, direct effects on populations, and ecosystem effects) and indicate sources of uncertainty in each stage of the analysis. (See also W89-01930) (Lantz-PTT)
W89-01955

AQUATIC SAFETY ASSESSMENT OF CHEMICALS SORBED TO SEDIMENTS,
Monsanto Co., St. Louis, MO.
For primary bibliographic entry see Field 5B.
W89-01957

ROLE OF PHYTOTOXICITY TESTS IN THE DERIVATION OF NUMERICAL NATIONAL WATER QUALITY CRITERIA,
Illinois State Water Survey, Peoria. Water Quality Section.
For primary bibliographic entry see Field 5G.
W89-01965

ENVIRONMENTAL IMPACT AND SIGNIFICANCE OF PESTICIDES,
National Water Research Inst., Burlington (Ontario).
W. M. J. Strachan, W. A. Glooschenko, and R. J. Maguire.
IN: Analysis of Pesticides in Water. Volume I: Significance, Principles, Techniques, and Chemistry of Pesticides. CRC Press, Inc., Boca Raton, FL. 1982. p 1-23, 2 fig, 157 ref.

Descriptors: *Environmental effects, *Pesticides, *Water pollution effects, *Fate of pollutants, *Path of pollutants, Organic compounds, Model studies, Toxicity, Monitoring, Organochlorine, Organophosphorus pesticides, Halogenated pesticides, Carbamates, Phenoxyalkanoic acid, Urea, Triazines.

Pesticide reactions of aquatic environmental interest can be divided into two broad types - abiotic and biological. In abiotic types, hydrolysis and photochemical processes are of the greatest general concern; in the biological type, the possibilities are extensive. Many of the processes of both types result in the same products and, while the rates of the abiotic processes can be determined in the laboratory and reasonably applied to the environment, those of a biological nature are dependent on the nature, numbers, and adaptation of the organisms involved and do not readily lend themselves to meaningful laboratory determination. Some qualitative definition of the nature of microorganisms in appropriate environmental compartments is possible, but this will be largely inadequate for the prediction of environmental rates without knowledge of the behavior of some reference substance(s) in both the environment of concern and in the test system. Pesticide types and properties (organochlorines, organophosphates, carbamates, phenoxyalkanoic acid derivatives, substituted urea, and triazines), transport and movement (in air, water and sediments), accumulation, degradation, modeling, toxicology and monitoring, are discussed. (See also W89-01968) (Lantz-PTT)
W89-01969

ECOLOGICAL PARAMETERS INFLUENCING AQUATIC PLANT GROWTH,
For primary bibliographic entry see Field 2E.
W89-01994

TECHNICAL REVIEW OF THE FACTORS AFFECTING AQUATIC USE OF DICHLOBENIL,
For primary bibliographic entry see Field 4A.
W89-02000

SCOPE OF THE PROBLEM,
Consultants in Environmental Sciences Ltd., London (England).
T. Rudd.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume I: Sources, Analysis, and Legislation. CRC Press, Boca Raton, Florida, 1987. p 1-29, 1 fig, 4 tab, 174 ref.

Descriptors: *Toxic wastes, *Heavy metals, *Water pollution effects, *Toxicity, *Sludge disposal, *Path of pollutants, Cadmium, Lead, Mercury, Nickel, Chromium, Zinc, Copper, Beryllium, Thallium, Silver, Tellurium, Vanadium, Arsenic, Selenium, Aluminum, Antimony, Lethal limits, Food chains, Ocean dumping.

The term heavy metals is frequently applied where there are connotations of toxicity, and thus a less vigorous definition of the group, normally used in the environmental context, is that it includes lighter metals such as aluminum and beryllium and metalloids such as As, Se, and Sb. Metalloids behave chemically both as a metal and a nonmetal; thus As, although not a metal in the strict chemical sense, is linked toxicologically to the heavy metals because of the sulfur-sequestering properties common to both. The ultimate cause for concern about heavy metals in the environment is their extreme toxicity towards man. Metal toxicity may be manifested in either acute or chronic forms, with acute toxicity encompassing the total adverse effect produced by a toxicant administered as a single dose or as multiple doses over a period of $<$ or $=$ to 24 hr. Acute or short-term metal toxicity is required to kill 50% of a population of test organisms in a fixed time period, e.g., 48 or 96 hr. A measurement of potential toxicity, similar to that of pH for hydrogen ion concentration, has been postulated, where pT is the negative log of the molar concentration of the toxic substance. pT has specified ranges for heavy metals of low (pT $= <$ 0.5), moderate (pT $=$ 5.0 to 7.0), and high (pT $= >$7.0) inherent toxicity. The fundamental factor which heightens the concern over the presence of potentially toxic heavy metals in the environment is their nonbiodegradability and consequent persistence. In addition to catastrophic incidences of large-scale localized inputs of metals from industrial sources, problems arise through gradual increases in metal concentrations from nonpoint source, particularly where water reuse is practiced. Concomitant with the problems posed by dispersal of liquid effluents are those of sludge disposal. The potential for toxic effects on humans resulting from sludge disposal to land varies with factors such as the nature and metal content of the soil and the sludge, the rate and frequency of sludge applica-

tion, the species of metals in the sludge and subsequently in the sludge-amended soil, the type of crop grown, and the part of the plant consumed. The toxicity of the 'heavy metals' is given as a brief summary for each these elements. (See also W89-02097) (Lantz-PTT)
W89-02098

TOXIC CONTAMINATION IN LARGE LAKES. VOLUME I: CHRONIC EFFECTS OF TOXIC CONTAMIMANTS IN LARGE LAKES.
Lewis Publishers, Chelsea, Michigan, 1988. 364p. Edited by Norbert W. Schmidtke.

Descriptors: *Lakes, *Water pollution effects, *Toxicity, *Ecological effects, *Limnology, Ecosystems, Bioaccumulation, Conferences, Polychlorinated biphenyls, Pesticides, DDT.

The first of four volumes on toxic contaminants in large lakes focuses on the chronic effects of pollution in large lakes. The paper included were presented at a conference on large lakes held in Michigan in May 1986. The 16 papers in the first volume cover such topics as quantification of toxic materials in fish from the Lawentian Great Lakes; toxic chemical effects in the Great Lakes; long-range transport of organochlorines in the artic and subarctic; pollution effects on algae; the OECD ecotoxicological basic test set on toxicity profiles of organic chemicals; human exposure routes to toxic chemicals in the Great Lakes; lead and mercury in the Mediterranean; and aerial transport and disposition of toxaphene. (See W89-02122 thru W89-02137; W89-02155; W89-02176) (Lantz-PTT)
W89-02121

ECOSYSTEM SURPRISE: TOXIC CHEMICAL EXPOSURE AND EFFECTS IN THE GREAT LAKES,
ELI-Eco Logic, Inc., Acton (Ontario).
D. J. Hallett.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 25-37, 1 tab, 19 ref.

Descriptors: *Water pollution effects, *Water pollution sources, *Toxicity, *Great Lakes, *Chemical exposure, DDE, Methyl mercury, Polychlorinated biphenyls, Bioaccumulation, Birds, Fish, Drinking water, Decontamination, Ecological effects.

The Great Lakes ecosystem has been adulterated with anthropogenic toxic chemicals since the advent of its industrialization. Sediment records indicate that a severe deceleration in deposition rate occurred from 1945 to 1960 when the rate leveled off. Persistent organic contaminants such as DDE, methyl mercury, and PCBs which bioaccumulate, were discovered from 1960 to 1970 in Great Lakes fish-eating birds which were suffering reproductive problems. Hundreds of persistent trace contaminant derivatives including chlorinated dioxins were discovered during the 1970s. Human health concerns arose first for the sale of commercial fish, then for consumption of sport fish and finally for drinking water. It was not until the 1980s that the surface interaction of the lakes with the atmosphere was linked for toxic chemicals. Total ecosystem pathways and exposure routes were considered rather than the effects in one aqueous ecosystem compartment. Humans were found to be contaminated with Great Lakes contaminants. In 1986, the major exposure route found was food. Decontamination of the ecosystem must proceed to prevent exposure to future generations. Major loadings of bioavailable contaminants circulating in the air, water and soil must be reduced. The hypothetical assessment of impact must be replaced with the estimation of loading potential, the cost to reduce loading sources, the extent of control possible, and the allocation of loading reductions. (See also W89-02121) (Author's abstract)
W89-02123

KNOWN EFFECTS OF POLLUTANTS ON FISH-EATING BIRDS IN THE GREAT LAKES OF NORTH AMERICA,
National Wildlife Research Centre, Ottawa (Ontario).
D. B. Peakall.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 39-54, 6 tab, 49 ref.

Descriptors: *Water pollution effects, *Birds, *Fish, *Food chains, *Great Lakes, Bald Eagle, Osprey, Herring gulls, DDE, Biochemistry, Physiological ecology, Thyroid, Porphyrins, Bird physiology, Lake Michigan.

By the mid 19700s, the general population aware that fish-eating birds had serious problems in the Great Lakes of North America. Marked declines of the population of the two fish-eating raptors - Bald Eagle and Osprey - and Double-crested Cormorant had occurred. Herring Gulls were experiencing poor reproductive success on Lake Michigan and Lake Ontario. There were reports of abnormalities in young Common Terns. In the case of the raptors and cormorant, eggshell thinning leading to reproductive failure appears to have been the major cause of the population declines. There is good evidence that the causative agent was DDE. Marked eggshell thinning was not observed in gulls and terns. Detailed studies on Herring Gulls showed the presence of both behavioral and embryotoxic effects. Reproductive success improved rapidly in the late 1970s and is now normal for all species except Foster's tern in Lake Michigan. Nevertheless, detailed investigations into the biochemistry and physiology of Herring Gulls still shown significant differences along the pollutant gradient within the Great Lakes when compared to marine colonies. These parameters include induction of mixed function oxidases, thyroid function, and levels of hepatic porphyrins. (See also W89-02121) (Author's abstract)
W89-02124

FISH TUMORS AS KNOWN FIELD EFFECTS OF CONTAMINANTS,
Roswell Park Memorial Inst., Buffalo, NY. Dept. of Experimental Biology.
J. J. Black.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 55-81, 5 fig, 2 tab, 56 ref.

Descriptors: *Fish, *Tumors, *Water pollution effects, *Great Lakes, *Lake Ontario, Black River, Ohio, Fox River, Illinois, Torch Lake, Michigan, Lake Erie, Niagara River, Case studies, Bullheads, Suckers, Toxicity, Cancer, Rainbow trout, Tissue analysis.

Case histories of neoplastic diseases affecting freshwater fish populations of the Great Lake region are described relative to their usefulness as known field effects of contaminants. Documented episootics of neoplasia have been found in: brown bullheads from the Black River, Ohio liver, oral, and skin neoplasms), the Fox River, Illinois various species and tumor types), Lake Ontario white suckers oral and liver neoplasms), Torch Lake, Michigan sauger exhibited nearly a 100% incidence of liver neoplasms), and eastern Lake Erie and the Niagara River where various species/tumor types have been identified. To the extent possible, the pollution scenarios associated with these case histories are described. Evidence linking cancer in fish to contaminant exposure is largely circumstantial, but the pollutant-fish cancer hypothesis is also supported by experiments which indicate that fish exposed to cancer causing substances in the controlled environment of the laboratory readily develop cancer. Controlled exposures using rainbow trout or small aquarium species are useful approaches to understanding similarities between various carcinogenesis models. Alternatively, wild fish such as bullheads and suckers can easily be adapted to a laboratory environment, and can provide direct evidence concerning the role of contaminants. Considerations of extrinsic factors such as exposure via contaminated benthic food chains relative to intrinsic factors such as differential competition between metabolic pathways of activation and detoxification have not been well studied. (See also W89-02121) (Author's abstract)
W89-02125

EFFECTS OF CONTAMINANTS ON ALGAE: AN OVERVIEW,
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Fisheries Research Branch.
M. Munawar, P. T. S. Wong, and G.-Y. Rhee.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 113-160, 12 fig, 140 ref.

Descriptors: *Water pollution effects, *Algae, *Great Lakes, *Lake Ontario, *Lake Superior, *Bioassay, Biological studies, Plankton, Sediments, Productivity, Benzene, Toxicity.

The use of algae in bioassays has recently gained momentum due to their simplicity, availability, sensitivity, rapidity of analysis, fast turnover rate and cost effectiveness. In the Great Lakes, the impacts of contaminants on aquatic systems were studied using in-vitro algal cultures and natural phytoplankton. Various size fractions such as ultraplankton and picoplankton (Algal Fractionation Bioassays) were used to assess differential toxicity. Studies included the synergistic impact of metal mixtures, nutrient/metals interactions, sediment-bound contaminants and organic compounds. Metal mixtures at Great Lakes Water Quality Objectives levels were toxic to the natural phytoplankton of both Lake Superior and Lake Ontario in various combinations. Algal Fractionation Bioassays indicated that the ultraplankton (2-20 micrometers) and picoplankton (< 20 micrometers) were significantly inhibited by the addition of the metal mixtures. The additions of nitrogen and phosphorus did not change the toxicity of the metal mixtures. The impact of sediment-associated contaminants including dredging, disposal, and navigational activities on phytoplankton productivity was investigated. Niagara River sediment was found to be extremely toxic. The navigational activities appear to have greater environmental impact on algae than the dredging and disposal activities. A comparative study with 13 chlorinated benzene compounds revealed a good correlation between toxicity and high chlorinated compounds. Algal toxicity testing, including the new microcomputer-based video analysis system and in-situ plankton cages have a tremendous potential in providing rapid, sensitive, inexpensive, and on-site evaluation of environmental perturbations. These new techniques will help to develop an early warning system based on reliable experimental data instead of expensive and routine chemical monitoring which lacks toxicological information needed for the preservation of the Great Lakes. (See also W89-02121) (Lantz-PTT)
W89-02127

TOXIC CONTAMINANTS AND BENTHIC ORGANISMS IN THE GREAT LAKES: CYCLING, FATE AND EFFECTS,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 5B.
W89-02128

EVALUATION OF TOXICITY PROFILES OF ORGANIC CHEMICALS: USEFULNESS OF ECOTOXICOLOGICAL BASIC TEST SET OF OECD,
Chemicals Inspection and Testing Inst., Oita (Japan). Hita Research Labs.
For primary bibliographic entry see Field 5A.
W89-02129

HUMAN EXPOSURE TO PERSISTENT AQUATIC CONTAMINANTS: A PCB CASE STUDY,
Michigan Dept. of Public Health, Lansing.
For primary bibliographic entry see Field 5B.
W89-02131

TOXIC CONTAMINATION IN LARGE LAKES. VOLUME II: IMPACT OF TOXIC CONTAMINANTS ON FISHERIES MANAGEMENT.
Lewis Publishers, Chelsea, Michigan, 1988. 330p.
Edited by Norbert W. Schmidtke.

Descriptors: *Fisheries management, *Water pollution effects, *Public relations, *Lakes, Research priorities, Public participation, Monitoring, Water quality control.

The second of four volumes on toxic contamination in large lakes focuses on the impact of pollution of fisheries mangaement. The papers included were presented at a conference on large lakes held in Michigan in May 1986. The 18 papers in the second volume cover such topics as fisheries management and water quality in Lake Kinneret, Israel; Lake Manzala, Egypt; Lake Orta, Italy; Lake Bwia, Japan; Lake Vanern, Sweden, and the Great Lakes. Other papers discuss the effects of pollution loading on fishery yields, fisheries in rivers and tropical lakes, predicting and monitoring effects of pollutants in large lakes, and the need for change in legal and public information. (See W89-02121; W89-02138 thru W89-02155; W89-02176) (Lantz-PTT)
W89-02137

FISHERY TRANSFORMATION ON LAKE MANZALA, EGYPT DURING THE PERIOD 1920 TO 1980,
Manitoba Dept. of Natural Resources, Winnipeg.
For primary bibliographic entry see Field 8I.
W89-02139

LAKE ORTA (N. ITALY): RECOVERY AFTER THE ADOPTION OF RESTORATION PLANS,
Istituto Italiano di Idrobiologia, Novara.
For primary bibliographic entry see Field 5G.
W89-02142

RIVERINE AND OTHER TROPICAL LAKES AND THEIR FISHERIES,
East-West Center, Honolulu, HI.
For primary bibliographic entry see Field 2H.
W89-02143

EFFECTS OF CONTAMINANTS LOADINGS ON FISHERIES YIELDS FROM LARGE LAKES,
Ontario Ministry of Natural Resources, Thunder Bay. Fisheries Research Section.
R. A. Ryder.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 169-173, 1 tab, 3 ref.

Descriptors: *Fisheries, *Lakes, *Water pollution effects, *Toxicology, Toxicity, Water pollution sources, Water pollution prevention, Cleanup operations, Fisheries management, Productivity.

Toxic contaminants may be of two fundamental types. The first type is 'natural' in the sense that the substance occurs commonly in nature, although normally at relatively low concentrations. These natural materials, though toxic at high concentrations, may be a metabolic necessity for fishes at trace levels. Many heavy metals fall into this category. Because fishes have evolved over eons in the presence of heavy metals, they have developed certain inherent adaptations to them at normal, ambient concentrations. The toxic effects of heavy metals from anthropogenic sources, therefore, are primarily those of increasing quantities, as concentrations augment beyond the genetic capability of the fish to adapt metabolically. The second category of contaminants consists of 'aberrant' substances created by man. Fishes have no evolutionary adaptation to these recently synthesized, xenobiotic materials. Generally, toxic effects of both natural and aberrant contaminants range from non-significant at extremely low concentrations to marked toxicity at high concentrations. In the case of high levels of toxic concentrations, most fish would succumb (close to 100% mortality) as would most other gill-breathing organisms, including both vertebrates and invertebrates. The sub-lethal effects of toxic contaminants on a fish community, and therefore, on fishery yields, are subtle, and insidious and virtually intractable from a management point of view. Rehabilitation measures may be most easily and economically put into place when the ecosystem is subjected to only low levels of contamination. At higher levels of toxic waste inputs, rehabilitative measures would likely be considered to be a suitable management option, particularly at the stage where fish become unfit for human consumption. (See also W89-02137) (Lantz-PTT)
W89-02145

PERSPECTIVES ON THE INFLUENCE OF TOXIC SUBSTANCES ON FISHERY PRODUCTIVITY,
Minnesota Univ., St. Paul. Dept. of Fisheries and Wildlife.
G. R. Spangler.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 193-207, 1 fig, 31 ref.

Descriptors: *Toxicity, *Water pollution effects, *Fisheries, *Great Lakes, Productivity, Model studies, Simulation analysis, Lethal limits, Mortality.

Repeated failure to achieve only moderately precise yield estimates, even for factors as important as sea lamprey predation on Great Lakes fish, has demonstrated the need for the development of more holistic models incorporating variables sensitive to population perpetuation. Very few holistic models have been applied to the problem of estimating contaminant effects, but recent progress in measuring latent mortality and sub-lethal contaminant effects suggest that it is not inappropriate to infer major contaminant influences from minor effects exhibited in the laboratory. Particle-size distribution models and general yield models of the morphoedaphic index type may be useful in estimating losses of fishery yield due to contaminants. In spite of the uncertainties associated with extrapolation of laboratory toxicity results to wild populations, simulations of anticipated impact have been applied to the estimation of fishery losses in the past, and will probably continue to provide low resolution estimates of short-term economic losses to the fishery where clear population compensatory processes can be identified. (See also W89-02137) (Lantz-PTT)
W89-02147

FISHES, FISHING AND POLLUTION IN LAKE VANERN (SWEDEN),
Eco Research and Resource Planning, Bromma (Sweden).
For primary bibliographic entry see Field 8I.
W89-02149

ADMINISTRATION OF THE FISH CONTAMINANT PROGRAM IN A DECENTRALIZED STATE AGENCY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
For primary bibliographic entry see Field 6E.
W89-02150

FRESHWATER FISHERIES MANAGEMENT AND POLLUTION IN BRITAIN: AN OVERVIEW,
Liverpool Univ. (England). Dept. of Zoology.
For primary bibliographic entry see Field 8I.
W89-02151

PREDICTING, VALIDATING AND MONITORING EFFECTS OF TOXICS ON LARGE LAKE ECOSYSTEMS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
J. Cairns.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 291-316, 36 ref.

Descriptors: *Prediction, *Monitoring, *Water pollution effects, *Lakes, *Toxicity, *Hazard assessment, Ecosystems, Water quality control, Fate of pollutants, Information exchange.

Most information on toxics has been generated with single species laboratory tests. Many species used are not key species in large lakes and the test conditions are low in environmental realism. Validation of predictions in rivers and small lakes is rare and almost non-existent in large lake ecosystem conditions. Similarly, most monitoring protocols and methods are designed to be used in streams, rivers, reservoirs, or small lakes. The lack of available information introduces an uncertainty into management decisions for large lakes and such decision are rarely as defensible as managers (and the public) would like them to be. To improve estimates of hazard due to toxics, the following suggestions are offered: (1) Data for hazard assessment should be gathered in a systematic, orderly way (i.e. protocol); (2) There must be recognition that some toxics require more testing than others; (3) The entire test series should consist of: (a) range finding tests, (b) predictive tests, (c) validation of predictions, and (d) quality control monitoring; (4) Avoid prescriptive legislation that ignores ecosystem differences (e.g. regulations prohibiting acidic discharges from artificial wetlands); (5) Couple environmental fate information with ecological effects information; (6) Involve ecotoxicologists from the beginning (i.e. research and development of the potentially toxic material) since they can advise on potential outcomes and sometimes determine when seemingly incompatible values might be in conflict; (7) Treat projects, where the outcome is highly uncertain, as experiments; (8) Public information in peer-reviewed professional journals; (9) Uncertainty is unavoidable but pretending it does not exist results in poor hazard evaluation. If uncertainty is dealt with in a straightforward way, managers are better prepared for alternative outcomes; (10) Always validate laboratory test result in natural systems or surrogates that have a higher degree of environmental realism than the laboratory systems; and (11) Even when a chemical appears 'safe' be alert for cumulative effects either with other chemicals or other environmental stresses (e.g. temperature extremes, low dissolved oxygen concentration). (See also W89-02137) (Lantz-PTT)
W89-02153

SIGNIFICANCE OF ATMOSPHERIC INPUTS OF TOXIC MATERIALS TO LARGE LAKES,
De Paul Univ., Chicago, IL. Dept. of Chemistry.
T. J. Murphy.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 83-96, 1 fig, 7 tab, 21 ref.

Descriptors: *Air pollution, *Lakes, *Water pollution sources, *Water pollution effects, Productivity, Meteorology, Climatology, Toxicity.

The factors which determine whether or not the atmosphere is a significant source of toxic materials to large lakes are discussed. Lakes with low productivity, relatively small drainage areas, can be expected to be the most affected by atmospheric inputs of toxic materials. While large lakes get much larger inputs of toxic materials from the atmosphere than smaller lakes do, large lakes are not necessarily more susceptible to atmosphere inputs than small lakes are. The effects of a large lake on the meteorology and climatology are found to change the inputs of materials from the atmosphere, and to complicate their determination. Most toxic materials have a residence time of only a few years in large lakes. Changes in the loadings of these materials, either increases or decreases, will be promptly reflected in the activity and toxicity of the material in a lake. Thus, pollution problems in large lakes are a reflection of recent practices. If these practices can be changed quickly, and the loading of the problem-causing toxic material decreased, then the lake should improve at a rate related to the residence time of that material in the water, and NOT on the residence time of the water

in the lake. (See also W89-02155) (Author's abstract)
W89-02161

TOXICOLOGY TESTING AS A CONTROL STRATEGY,
Chemical Industry Inst. of Toxicology, Research Triangle Park, NC.
For primary bibliographic entry see Field 5G.
W89-02164

DEGRADATION OF LAKE BAIKAL: FATE AND EFFECTS OF CONTAMINANTS PRESENT,
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
For primary bibliographic entry see Field 5B.
W89-02171

LAKE-WIDE IMPACTS OF LONG-TERM SOURCES OF XENOBIOTIC CONTAMINANTS: LAKE MANAGUA (NICARAGUA) AND LAKE MICHIGAN (UNITED STATES),
Amsterdam Univ. (Netherlands). Vakgroep Aquatische Oecologie.
W. R. Swain.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 389-427, 13 fig, 9 tab, 48 ref.

Descriptors: *Water pollution effects, *Water pollution sources, *Lake Managua, *Nicaragua, *Lake Michigan, Mercury, Polychlorinated biphenyls, Municipal wastewater, Industrial wastes, Public health, Drinking water.

The effects of long-term additions of toxic xenobiotic materials were examined for two large lake ecosystems: Hg added to Lake Managua, Nicaragua and polychlorinated biphenyl compounds (PCBs) in Lake Michigan, United States. In addition, the data available for municipal discharges of untreated domestic sewage were considered for Lake Managua. Between 1968 and 1980, a total of 18,000 kg of Hg was discharged to Lake Managua from a chlor-alkali manufacturing facility which utilized a dropping-mercury cathode to produce chlorine. A 1983 survey reports sediment values ranging from 1.63 to 210 mg Hg/kg in the embayment adjacent to the industrial outfall. Fish and water column data suggest a lake-wide dispersion of the material. With recent increases in loss rates, the estimated total loading is of the order of 37,000 kg Hg to Lake Managua since the initiation of industrial operations in 1968. The effects of a former industrial discharge and a contemporary in-situ source of PCBs were examined for Lake Michigan. During the period 1955-1970, a manufacturer of internal combustion engines purchased and presumably used chemical formulations of materials containing an estimated 5,300,000 kg PCB. Residual sedimentary values of PCB in the harbor complex which received the discharges (Waukegan, Illinois) range from 74 to 16,400 mg PCB/kg and from 1.2 to 246,000 mg/kg in an adjacent small tributary to Lake Michigan. The impacts of these contaminating additions are considered on a lake-wide basis for each of the two large lake ecosystems, and the impacts on biota are examined. In each case, the potential for human exposure to toxic residue-forming contaminants is considered; primarily by ingestion of Lake Michigan fish, and by consumption of drinking water derived from a lagoon influenced by the waters of Lake Managua. (See also W89-02155) (Lantz-PTT)
W89-02175

HEALTH IMPLICATIONS OF GROUNDWATER CONTAMINANTS,
Michigan State Univ., East Lansing. Center for Environmental Toxicology.
M. A. Kamrin.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 225-233, 1 tab.

Descriptors: *Water pollution effects, *Public health, *Toxicity, *Human diseases, *Groundwater pollution, Cancer, Behavior, Reproduction.

The issue of health effects of water contaminants has returned to public attention; however, this time with respect to chemical rather than biological contaminants. Chemicals can be detected at minute levels, parts per trillion in many cases and even lower in some. Possible health effects, however, vary tremendously from nonspecific symptoms such as headhache and nausea to life-threatening illnesses such as liver damage and cancer. There are three basic approaches to assess: direct measures of the environment (groundwater in this case), indirect measures of the environment (e.g. sentinel animals), and direct examination of the population thought to be exposed. Exposure assessment is not a very exact process when applied to the health effects of most concern -- chronic toxicity. It is most often the limiting factor in trying to appraise the connection between an environmental contaminant and toxicity accurately. The techniques available for assessment of chronic toxicity (reproductive damage, behavioral effect, cancer), especially carcinogenicity, provide rather clear evidence as to whether or not a particular chemical causes a particular effect in animals. However, they are not designed to provide quantitative assessments at environmentally relevant levels; and their applicability to human populations is not clear, especially as to the exact levels which give rise to a particular outcome. These uncertainties, taken together with the difficulties in exposure assessment, contribute to the current absence of definite conclusions about the relationship between most environmental exposures and chronic health effects. (See also W89-02196) (Lantz-PTT)
W89-02211

5D. Waste Treatment Processes

SEASONAL VARIATIONS OF PHYTOPLANKTON IN A SERIES OF WASTE TREATMENT LAGOONS (CHIMKENT, CENTRAL ASIA): I. ARTIFICIAL INOCULATION AND ROLE OF ALGAE IN SEWAGE PURIFICATION,
A. E. Ergashev, and S. Tajiev.
Internationale Revue der Gesamten Hydrobiologie IGHYA2, Vol. 71, No. 4, p , 1986.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Phytoplankton, *Algae, Artificial inoculation, Seasonal variation, Asia, USSR.

Increasing the number of species by means of artificial introduction of algae was studied. Algae collected from fish ponds, roadside pits, deep cuts, and temporary water bodies were temporarily incubated in 20-l bottles and then added to sewage treatment ponds. Altogether there were recorded 212 species and forms: 128 in spring, 165 in summer, 119 in autumn and 61 in winter in all the ponds inoculated. The maximal cell number of phytoplankton occurs in summer, the minimal in winter. The active role of algae in the sewage purification is shown. It is concluded that the ponds are efficient in biological wastewater treatment under Central Asian conditions. (Sand-PTT)
W89-01275

PACKED- AND FLUIDIZED-BED BIOFILM REACTOR PERFORMANCE FOR ANAEROBIC WASTEWATER TREATMENT,
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Dept. of Chemical Engineering.
M. Denac, and I. J. Dunn.
Biotechnology and Bioengineering BIBIAU, Vol. 32, No. 2 , p 159-173, July 5, 1988. 23 fig, 5 tab, 20 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Fluidized bed process, *Packed bed process, Biofilm reactors, Comparison studies, Performance evaulation, Chemical oxygen demand, Molasses, Whey.

Anaerobic degradation performance of a laboratory packed-bed reactor (PBR) was compared with two fluidized-bed biofilm reactors (FBR) on molasses and whey feeds. The reactors were operated under constant pH (7) and temperature (35 C) conditions and were well mixed with high recirculation rates. As carrier, sand of 0.3-0.5 mm diameter was used in the FBR, and porous clay spheres of 6 mm diameter were used in the PBR. Start-up of the PBR was achieved with 1-5 day residence times. Start-up of the FBR was only successful if liquid residence times were held low at 2-3 h. Chemical oxygen demand (COD) degradations of 86% with molasses were reached in both reactors at 6 h residence time and loadings of 10 g COD/L day. The results of dynamic step change experiments, in which residence times and feed concentrations were changed at constant loading, demonstrated the rapid response of the reactors. Thus, the response times for an increase in gas rate or an increase in organic acids due to an increase in feed concentration were less than 1 day and could be explained by substrate limitation. Other slower responses were observed in which the reactor culture adapted over periods of 5-10 days; these were apparently growth related. An increase in loading of over 100% always resulted in large increases in organic acids, especially acetic and propionic, as well as large increases in the CO_2 gas content. In general, the CO_2 content was very low due to the large amount of dissolved CO_2 that exited with the liquid phase at low residence times. The performance of the FBR with whey was comparable to its performance with molasses, and switching of molasses to whey feed resulted in immediate good performance without adaptation. (Author's abstract)
W89-01284

NUTRIENT REMOVAL BIOLOGICAL OXIDATION OF AMMONIA NITROGEN,
V. Stack.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 21 No. 4, p 9-11, July-August 1988. 2 fig.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Activated sludge, Nutrient removal, Ammonia nitrogen, Temporal variation, Shock loads.

In biological systems that process ammonia-N as the primary source of energy, short-term variations in ammonia-N loading (a few hours to 1 day) will be seen in the effluent because of the long generation period for the nitrification organisms. In domestic wastewater systems, the breakthrough of ammonia-N at peak loading is less than might be expected because of the buffering provided by the uptake of ammonia-N in synthesis reactions. Industrial ammonia-N should be equalized before discharge and adequate alkalinity should be available so that a population of nitrification organisms will develop to process to waste. If this is not done, peak concentrations from slug load could pass through the treatment plant. (Author's abstract)
W89-01286

BIOLOGICAL NUTRIENT CONTROL BY THE A/O PROCESS,
K. D. Tracy.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 21 No. 4, p 22-26, July-August 1988. 5 fig, 1 tab, 7 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Activated sludge, Nutrient removal, Phosphorus removal, Biochemical oxygen demand, Design criteria.

Biological phosphorus removal is made possible by a survival mechanism that allows certain microorganisms to take up BOD under anaerobic conditions using energy from stored polyphosphates. Because of the interaction between BOD removal and P storage the BODs/P (soluble biochemical oxygen demand to orthophosphate ratio) and Fs/M (soluble BOD to biomass) ratios are important design variables. P removal is favored by high values of both ratios. Data from full-scale facilities has shown that long-term reliability of P removal can be maintained with nitrification alone or with nitrification and denitrification. (Author's abstract)
W89-01287

HISTORY OF POINT SOURCE CONTROL OF NUTRIENTS IN PENNSYLVANIA AND OTHER CHESAPEAKE BAY STATES: PART I,
W. A. Lyon.
Water Pollution Control Association of Pennsylvania Magazine Vol. 21, No. 4, p 34-37, July-August 1988. 4 fig.

Descriptors: *Water pollution control, *Chesapeake Bay, *Pennsylvania, *Eutrophication, *Water pollution sources, *Environmental policy, Path of pollutants, Great Lakes, Susquehanna River, Wastewater facilities, Nitrogen, Phosphorus, Lake Erie, Lake Ontario, Environmental Protection Agency, Industrial wastes, Nonpoint pollution sources, Nutrients, Sedimentation, Estuaries, Hurricanes.

The sources of nutrients reaching the Chesapeake Bay are discussed. The pollution of the Chesapeake Bay is compared with that in the Lower Great Lakes Basin. The need for control of nutrients derives from the process of eutrophication, which is a natural process that is accelerated by human activities, agricultural runoff, animal wastes, septage, and some industrial wastes. These problems were recognized in reports submitted in the late 1960s and early 1970s concerning Lakes Erie and Ontario. Similarly, in 1983 the Environmental Protection Agency's Chesapeake Bay Framework for Action' report described the adverse effects of nutrients on this body of water. Point sources recognized were municipal sewage treatment plants and some industrial waste treatment facilities that release N- and P-containing effluents. Publicly owned treatment works are the major sources of N and P to the Chesapeake Bay. Municipal loadings also enter the Bay in the discharge from the Susquehanna River basin (2.9 million pounds of P during an average rainfall year). Nonpoint sources of phosphorus are mainly farm animal wastes, dead vegetation, fertilizers applied to fields, and effluents from storm sewers and combined municipal sewers. A significant share of the nonpoint inputs results from natural processes, such as sediment input from Hurricane Agnes in 1972, which created 60 acres of islands in the Bay. The EPA report makes no distinction between natural and man-made nonpoint sources. (See also W89-01289) (Rochester-PTT)
W89-01288

HISTORY OF POINT SOURCE CONTROL OF NUTRIENTS IN PENNSYLVANIA AND OTHER CHESAPEAKE BAY STATES: PART II,
For primary bibliographic entry see Field 5G.
W89-01289

EFFECT OF OIL EMULSIONS ON THE COUNTER CURRENT AIR STRIPPING OF TOLUENE,
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
D. H. Zitomer.
Water Pollution Control Association of Pennsylvania Magazine Vol. 21, No. 5, p 18-25, September-October 1988. 4 fig, 3 tab, 15 ref.

Descriptors: *Oily water, *Toluene, *Air stripping, *Emulsions, *Wastewater treatment, *Industrial wastewater, Leachates, Hazardous materials, Performance evaluation, Volatile organic compounds, Wastewater facilities.

A bench-scale counter current air stripping column was employed to remove toluene from a mineral oil/water emulsion. The mineral oil was used to simulate floatable oil and grease commonly found in wastewaters typical of hazardous waste site leachates, petroleum, chemical and metal finishing industries, and other similar wastewaters containing volatile organic compounds (VOCs) in addition to oily constituents. Toluene removal was retarded by oil emulsions. Retardation of toluene removal increased as mineral oil concentration increased. The relationship between retardation of toluene removal and oil concentration was expressed as a linear function with a correlation coefficient of 0.92. Toluene removal efficiency was reduced less than 10% when the oil concentration was 500 mg/L or less. At an oil concentration of 3363 mg/L, removal efficiency was only 30% of what would have been expected in the absence of oil. It can be inferred from these laboratory results that counter current air stripping of VOCs from oily wastewaters may be possible if the concentration of oily constituents is relatively low. (Author's abstract)
W89-01290

'WHO'S ON FIRST' WITH RIGHT TO KNOW,
For primary bibliographic entry see Field 6E.
W89-01291

RECENT SEWAGE FINANCING IN PENNSYLVANIA,
Collings, Legg, Mason, Inc., Philadelphia, PA.
For primary bibliographic entry see Field 6C.
W89-01292

MARKETING SLUDGE COMPOST IN JAPAN,
Japan Sewage Works Agency, Toda. Research and Technology Development Div.
For primary bibliographic entry see Field 5E.
W89-01294

VARIATION IN PROPERTIES OF SEWAGE SLUDGE,
Neya River Basin - Wide Sewage Works Association, Osaka (Japan).
T. Hanasaki, H. Ohnishi, S. Tanada, and T. Aratani.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 1, p 121-126, July 1988. 6 fig, 1 tab, 1 ref.

Descriptors: *Wastewater treatment, *Sludge, *Activated sludge, Sludge thickening.

For proper operation and management of processes of sewage sludge disposal, both seasonal and long-term variations in the properties of sludge have to be made clear. A time series analysis of the sludge properties was performed in order to clarify the annual and long-term changes. Two variables were considered, i.e. sludge concentration and sludge organic ratio of the concentrated sludge. The sludge concentration increases in summer and decreases in winter with a maximum-minimum difference of about 3%, while the sludge organic ratio toward a maximum-minimum difference of about 30%. Each of the two variables changes periodically with a period of 360-380 days. The periodicity of these two variables gradually becomes less prominent over time. To investigate the long-term variations in the properties of sludge, time series data were subjected to a linear regression analysis. The trend equations of the sludge concentration indicate an annual decrease of about 0.25%. Similarly, the sludge organic ratio increases about 2.0%, indicating a worsening tendency over a long period. The trend regarding the amount of treated water was calculated and it was inferred that the amount increased annually by 5500 cu m. This increase has a close relation with the spread of the sewerage system. An increase in treated water will result in a rise in sludge organic ratio, leading to a decrease in the sludge concentration. This will finally affect the sludge concentration capability. (Sand-PTT)
W89-01302

REACTION OF ORGANIC PHOSPHATE ESTERS WITH CHLORINE IN AQUEOUS SOLUTION,
Kitakyushu Municipal Inst. of Environmental Health Sciences (Japan).
For primary bibliographic entry see Field 5B.
W89-01303

EUTROPHICATION OF THE COASTAL WATERS OF THE NORTH ADRIATIC SEA: NATIONAL AND REGIONAL INTERVENTION PROGRAMS,
Emilia-Romagna Regional Authorities, Bologna (Italy).
For primary bibliographic entry see Field 5C.
W89-01304

EUTROPHICATION OF INLAND AND COASTAL WATERS IN ITALY,
Istituto di Ricerca sulle Acque, Milan (Italy). Reparto Sperimentale di Idrobiologia Applicata.
For primary bibliographic entry see Field 5C.
W89-01305

CORRELATION OF COMPOUND PROPERTIES WITH BIOSORPTION OF ORGANIC COMPOUNDS,
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
A. Selvakumar, and H. N. Hsieh.
Journal of Environmental Science and Health (A) JESEDU, Vol. 23, No. 6, p 543-557, 1988. 4 fig, 3 tab, 6 ref.

Descriptors: *Wastewater treatment, *Organic compounds, *Sorption isotherms, *Activated sludge, *Nitrogen fixing bacteria, Biomass, Phenols, Benzenes, Chlorinated hydrocarbons, Biological wastewater treatment.

The sorption of organic compounds (phenol, 2-chlorophenol, 2-nitrophenol, chlorobenzene, ethylbenzene) by inactive microbial biomass was investigated using (1) dewatered activated sludge and (2) nitrifying bacteria from a wastewater treatment plant. The sorption isotherms were linear over the range of concentrations (50-200 mg/l) studied. The linear partition coefficients were directly related to organic carbon content of the biomass. Octanol/water partition coefficient is a much better predictor of extent of adsorption on biomass than aqueous solubility. Reasonable estimation of the sorption behavior of organic pollutants can be made from a knowledge of organic carbon content of the biomass and octanol/water partition coefficient of the organic pollutants. (Author's abstract)
W89-01325

OPTIMAL ORGANICS REMOVAL IN SAND BEDS, TREATING INDUSTRIAL INFLUENT,
Baghdad Univ. (Iraq). Coll. of Engineering.
S. A. Musa, N. Al-Masri, and S. Sabri.
Journal of Environmental Science and Health (A) JESEDU, Vol. 23, No. 6, p 569-583, 1988. 4 fig, 8 tab, 10 ref.

Descriptors: *Wastewater treatment, *Food-Processing wastes, *Organic compounds, *Chemical oxygen demand, Industrial water, Sand beds.

The use of sand beds was investigated for treating a beer factory wastewater for organic content removal based upon the chemical oxygen demand (COD). Optimum COD removal percentages were 90 to 96% for sand depth 61 to 82.5 cm and applied influent COD concentrations of 1550 to 2125 mg/l. Prediction models of the bed - COD removal percentage in terms of sand depth and influent concentration were determined. The models are able to predict COD removal percentages of sand beds as depths varied from 20 to 100 cm and maximum influent COD concentrations of 2500 mg/l. (Sand-PTT)
W89-01327

EFFECTS OF SURFACE-ACTIVE AGENTS ON THE SALINITY TOLERANCE OF WATER HYACINTH (EICHHORNIA CRASSIPES),
Okayama Univ., Kurashiki (Japan). Inst. for Agricultural and Biological Sciences.
S. Muramoto, and Y. Oki.
Journal of Environmental Science and Health (A) JESEDU, Vol. 23, No. 6, p 603-611, 1988. 4 fig, 1 tab, 10 ref.

Descriptors: *Aquatic plants, *Floating plants, *Water hyacinth, *Wastewater treatment, *Surfactants, Estuaries, Sodium dodecyl sulfate, Salinity.

Water hyacinth (Eichhornia crassipes (Mart.) solms) has received attention because of its potential for removal of pollutants when utilized as a biological filtration system. The influence of levels of salinity and surface-active agents in water for the growth of water hyacinth plants was determined. The lethal level of salinity for water hya-

cinth is between 6.0 - 8.0% of sea water, which is higher than the level of 2.3% reported several years ago. (Author's abstract)
W89-01329

PRACTICAL APPLICATION OF VARIOUS TECHNIQUES TO CONTROL SLUDGE BULKING,
Port Elizabeth City Engineer's Dept. (South Africa).
R. W. Wakefield, and J. A. Slim.
Journal of the Institution of Water and Environmental Management, Vol. 2, No. 3, p 311-318, June 1988. 3 fig, 3 tab, 10 ref.

Descriptors: *Bulking sludge, *Activated sludge, *Wastewater treatment, Sludge, Sludge drying, Sludge thickening, Chlorination, Suspended solids, Aeration, Water reuse, South Africa.

The Fishwater Flats water reclamation works in Port Elizabeth, South Africa has been severely affected by activated-sludge bulking since its commissioning in 1976. This paper describes the control measures which have been investigated on a full plant scale, together with the results obtained from: (1) chlorination of return activated sludge; (2) the installation of selectors; and (3) modification of the feed pattern. Results indicate that sludge bulking can be controlled. Sludge bulking is a phenomenon which occurs in activated sludge plants whereby the activated sludge occupies an excessive volume and does not settle readily so that in extreme cases the effluent from the secondary settlement tanks contains an excessive amount of suspended matter. This problem is usually associated with the presence of filamentous organisms. (Author's abstract)
W89-01354

DESIGN AND CONSTRUCTION OF THE ISLE OF DOGS PUMPING STATION,
Halcrow (William) and Partners, London (England).
M. B. Bennett, I. G. Harmond, R. A. Legg, and J. Lewin.
Journal of the Institution of Water and Environmental Management, Vol. 2, No. 3, p 319-331, June 1988. 4 fig, 3 tab, 4 ref, append.

Descriptors: *Hydraulic design, *Construction, *Pumping plants, *Pumps, *Stormwater drainage, *London, England, Automation, Telemetry, Hydraulic machinery, Screens, Model studies, Surge tanks, Outfall, Sediment transport, Zoning, Pipelines, Control systems, Engineering, Civil engineering, Architecture, Electrical equipment.

The pumping station of the newly developed Enterprise Zone of the Isle of Dogs, London is described. The station employs submersible pumps to drain surface water from the zone and discharges storm overflows from an existing combined sewer system. At full development, the nominal capacity of the pumps will be 12 cu m/s. After screening, the flow passes to the pump chamber, where 12 main and two sump pumps are located. The main pumps deliver through individual syphon discharge pipes to a high level surge tank, which drains by gravity through a short outfall to the river Thames. Diaphragm walling was used in the construction of the foundations and underground work. Attractive brick buildings form the pump hall and building housing the high voltage electrical equipment and the transformers. Steel sheet piles protect the river frontage. The station will operate unattended, and will be controlled automatically by water level sensors. Supervision will be by telemetry links to the Thames Water Authority's (TWA) area control center at Abbey Mills. (Author's abstract)
W89-01355

TREATING INDUSTRIAL PLANT WASTEWATER: MEETING TODAY'S COMPLIANCE CHALLENGES,
BCM Engineers, Mobile, AL.
J. E. Norris.
Consulting/Specifying Engineer, Vol. 3, No. 3, p 94-96, March 1988. 2 tab.

Descriptors: *Wastewater treatment, *Wastewater facilities, *Water quality, *Pollutant identification, *Design standards, Water Quality Act, *legal aspects, Standards, Regulations, Compliance.

The organic chemicals industry is used as an example to demonstrate the importance of industrial wastewater treatment analytical and compliance issues. Even utilizing the best available treatment (BAT) technology (i.e., in-unit carbon absorption, stream stripping, biological treatment and final end-of-pipe biological treatment) cannot assure compliance with recently established effluent limits. Examples of the analytical difficulties are presented using the models effluents containing the pollutants benzene, ethylbenzene, chloroform, 2,4-dimethylphenol, and 4-nitrophenol. Good design and rigorous operation of wastewater treatment facilities does not guarantee compliance. Close attention must be paid to the taking of good analytical samples and to the application of good analytical science in the laboratory. A mature evaluation of the data and recognition of its inherent uncertainty also is a must. (Roseman-PTT)
W89-01400

INTERACTIONS BETWEEN CHLOROLIGNIN AND POLYSULFONE ULTRAFILTRATION MEMBRANES,
Lappeenrannan Teknillinen Korkeakoulu (Finland).
M. Lindstrom, M. Nystrom, and M. Laatikainen.
Separation Science and Technology SSTEDS, Vol. 23, No. 6 and 7, p 703-717, 1988. 8 fig, 2 tab, 15 ref.

Descriptors: *Pulp wastes, *Bleaching wastes, *Fouling, *Membrane processes, *Membrane filters, *Wastewater treatment, Chemical properties, Ultrafiltration, Chlorolignin, Polysulfone.

Interactions between chlorolignin and polysulfone ultrafiltration membranes have been studied by means of direct adsorption measurements and ultrafiltration experiments. Electrostatic repulsion between the negatively charged polyions and the surface of the membrane seems to govern ultrafiltration of chlorolignin at pH $>$ 5, which was characterized by high retention and relatively low flux reduction. At these pH values, adsorption of chlorolignin on polysulfone surfaces was negligible and irreversible fouling of the membrane did not occur. Flux reduction at high pH values was caused mainly by penetration of a small fraction of chlorlignin molecules into the pores of the membrane, which caused frictional flux reduction and lower retention. These phenomena were bound to the bulk concentration of chlorolignin in solution. At low pH values, adsorption of chlorolignin in the pores of polysulfone membranes may cause fouling which can be purged by washing with alkaline solutions. At low pH values, the tendency of chlorolignin to gel also can cause gel layer formation on the surface of the membrane. This gel layer may act as a secondary membrane which affects retention and flux in a way which is difficult to predict. (Hammond-PTT)
W89-01438

TREATMENT OF BLEACHING WATERS IN THE PAPER INDUSTRY BY HYDROGEN PEROXIDE AND ULTRAVIOLET RADIATION,
Barcelona Univ. (Spain). Dept. Ingenieria Quimica y Metalurgia.
C. Prat, M. Vicente, and S. Esplugas.
Water Research WATRAG, Vol. 22, No. 6, p 663-668, June 1988. 6 fig, 2 tab, 13 ref.

Descriptors: *Bleaching wastes, *Oxidation, *Ultraviolet radiation, *Pulp wastes, *Wastewater treatment, Cost analysis, Hydrogen peroxide, Industrial wastes, Photochemistry, Kinetics, Color, Hydrogen ion concentration.

The use of hydrogen peroxide combined with ultraviolet radiation was examined for the treatment of wastewaters from the chlorination and extraction stages of paper pulp bleaching. The kinetic constants corresponding to the elimination of color from these effluents and their variation with the pH of the medium were determined. For a similar reaction time, the color reduction of the effluent was greatest at basic pH. Hydrogen peroxide combined with ultraviolet radiation always leads to a greater reduction of color in the effluent than when this oxidant is used in darkness, but the method is not economically competitive. This is because the improvement in the rate of reaction is not high enough to compensate for the complexity of the necessary installation or the additional operating costs. (Rochester-PTT)
W89-01443

MAXIMUM LIKELIHOOD ANALYSIS OF DISINFECTION KINETICS,
Illinois Inst. of Tech., Chicago. Pritzker Dept. of Environmental Engineering.
C. N. Haas.
Water Research WATRAG, Vol. 22, No. 6, p 669-677, June 1988. 6 fig, 7 tab, 27 ref.

Descriptors: *Disinfection, *Kinetics, *Frequency distribution, *Water treatment, *Wastewater treatment, *Regression analysis, *Bacterial analysis, Maximum likelihood, Comparison studies, Performance evaluation, Errors.

Disinfection kinetics may be ascertained from experiments using plate-count (or analogous plaque-count) assays using sequential linear regression, nonlinear least squares regression, or maximum likelihood estimation (assuming Poisson replication errors). It is demonstrated that the last of these procedures yields estimates of inactivation parameters of lesser bias and variance than the other two procedures, even when the true between-replicate errors are distributed with variances exceeding the Poisson distribution. (Author's abstract)
W89-01444

TREATMENT OF LANDFILL LEACHATES IN ON-SITE AERATED LAGOON PLANTS: EXPERIENCE IN BRITAIN AND IRELAND,
Aspinwall and Co., Shrewsbury (England).
H. D. Robinson, and G. Grantham.
Water Research WATRAG, Vol. 22, No. 6, p 733-747, June 1988. 8 fig, 4 tab, 13 ref.

Descriptors: *Landfill leachates, *Aerated lagoons, *Wastewater treatment, *Leachate treatment, *Domestic wastes, Lagoons, Ammonia, Organic compounds, Biological oxygen demand, Iron, Manganese, Zinc, England, Wales, Ireland, Chemical oxygen demand, Landfills, Automation, Economic aspects, Performance evaluation.

A full-scale, automated leachate treatment plant has been operated since mid-1983 at the Bryn Posteg Landfill Site, in mid-Wales. The plant has provided high-quality data on both technical and economic aspects over 3 yr of operation. The leachate treatment plant is centered on a large aerated lagoon with a long ($>$ 10 days) mean period of retention; control systems enable treatment to be accomplished in an almost completely-automatic manner, with minimal attention. During the first 30 mo of continuous operation of the plant, including 2 summers and 3 winters, the BOD of leachate being treated exceeded 10,000 mg/l for extended periods (flow-weighted mean value 3700 mg/l). The effluent BOD has rarely exceeded 50 mg/l (flow-weighted mean 18 mg/l). Better than 97% removal of COD has been maintained, together with excellent removal of ammonia, iron, manganese, and zinc. Treatment costs are outlined and summarized. Two similar plants at Wiltshire (England) and County Louth (Southern Ireland) are described briefly. (Author's abstract)
W89-01451

SCUM ACTINOMYCETES IN SEWAGE TREATMENT PLANTS: PART 1. GROWTH KINETICS OF NOCARDIA AMARAE IN CHEMOSTAT CULTURE,
Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).
M. Baumann, H. Lemmer, and H. Ries.
Water Research WATRAG, Vol. 22, No. 6, p 755-759, June 1988. 1 fig, 2 tab, 15 ref. Kuratorium fuer Wasserwirtschaft Grant C00-1.07/83.

Descriptors: *Actinomycetes, *Biological wastewater treatment, *Model studies, *Scum, *Kinetics, Monod equation, Sludge bacteria, Wastewater treatment, Bacteria, Chemostats, Batch culture, Continuous culture, Comparison studies, Numerical analysis, Physiological ecology, Bacterial growth, Mathematical models.

The scum actinomycete Nocardia amarae was grown in batch culture and in chemostat culture on a fructose-peptone-yeast extract substrate. Chemostat growth was modeled with a two-substrate Monod equation incorporating six parameters, including maximum growth, kinetic constants for substrate and oxygen, cell yield, and wall growth. These parameters were identified by numerically optimizing the fit. Among the parameters, maximum growth rate = 0.087 + or - 0.0075/hr and K sub S = 675 + or - 124 mg/l, a value much higher than reported for other sludge bacteria. The results are compared with published findings for other sludge bacteria and the different growth strategies of these organisms are discussed. (See W89-01454 thru W89-01455) (Author's abstract)
W89-01453

SCUM ACTINOMYCETES IN SEWAGE TREATMENT PLANTS: PART 2. THE EFFECT OF HYDROPHOBIC SUBSTRATE,

Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).
H. Lemmer, and M. Baumann.
Water Research WATRAG, Vol. 22, No. 6, p 761-763, June 1988. 1 tab, 6 ref. Deutsche Forschungsgemeinschaft Grant Po231/1-3.

Descriptors: *Actinomycetes, *Biological wastewater treatment, *Activated sludge, *Scum, *Hydrophobic compounds, Industrial wastewater, Hexadecane, Antifoaming agents, Dodecylbenzenesulfonate, Sludge bacteria, Wastewater treatment, Bacteria, Physiological ecology, Bacterial metabolism, Residence time, Substrates, Surfactants.

The effect of the addition of several hydrophobic substrates (hexadecane, industrial wastewater with a high content of nonpolar hydrocarbons, silicone antifoaming agent, and dodecylbenzenesulfonate) on the growth of Nocardia amarae in activated sludge was investigated in bench-scale sewage treatment plants at different F/M ratios of readily degradable substrate (nutrient broth). In all cases addition of hydrophobic substances enhanced the competitional success of N. amarae within the sludge biocenosis compared to the controls. The effect was most pronounced at low F/M ratios (i.e., 0.07-0.15 kg/kgd). Reasons for the observed results include the utilizability of these substrates as selectively available food and the physical effects that increase the mean cell residence time of actinomycetes. (See also W89-01453 and W89-01455) (Author's abstract)
W89-01454

SCUM ACTINOMYCETES IN SEWAGE TREATMENT PLANTS: PART 3. SYNERGISMS WITH OTHER SLUDGE BACTERIA,

Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).
H. Lemmer, and M. Baumann.
Water Research WATRAG, Vol. 22, No. 6, p 765-767, June 1988. 1 tab, 7 ref. Deutsche Forschungsgemeinschaft Grant Po231/1-3.

Descriptors: *Synergistic effects, *Actinomycetes, *Biological wastewater treatment, *Activated sludge, Sludge bacteria, Wastewater treatment, Polysaccharides, Bacteria, Biodegradation, Denitrification, Biomass, Biogas, Flotation, Physiological ecology.

Three types of synergisms by which the success of actinomycetes in the activated sludge biocenosis might be enhanced by other sludge bacteria were investigated. No evidence was found that Pseudomonas sp., Alcaligenes sp., Flavobacterium sp., Acinetobacter sp., and samples of activated sludge were able to degrade polysaccharides in activated sludge and provide actinomycetes with soluble sugars. No evidence was found that gas bubbles, which cause flotation of activated sludge, originate in N2 from denitrification processes or in H2S-production from activated sludge sampled from the secondary clarifier. Biomass production of two-strain cultures of Nocardia amarae with Pseudomonas sp., Alcaligenes sp., Flavobacterium sp., and Acinetobacter sp. was compared with axenic growth. N. amarae growing together with Acinetobacter sp. showed significantly higher biomass production than the sum of the biomass production of the axenic controls. For the other pairs no significant synergism was detected. (See W89-01453 thru W89-01454) (Author's abstract)
W89-01455

FLOW THROUGH ACTIVATED SLUDGE FLOCS,

Toronto Univ. (Ontario). Dept. of Civil Engineering.
D. -H. Li, and J. Ganczarczyk.
Water Research WATRAG, Vol. 22, No. 6, p 789-792, June 1988. 3 fig, 2 tab, 19 ref.

Descriptors: *Activated sludge, *Flocs, *Flow patterns, *Permeability, *Fluid mechanics, *Porosity, Wastewater treatment, Biological wastewater treatment, Biomass, Sedimentation, Settling velocity, Activated carbon, Coke, Resins.

Experimental evidence is presented to support the hypothesis of Hung and Logan that fluid flows through activated sludge flocs. The evidence was obtained from a sedimentation study of activated sludge flocs formed with and without impermeable carriers. The settling velocities of carrier/activated sludge flocs formed in the presence of activated carbon, coke, and resin were at least no higher than the settling velocities of the comparable size flocs formed without carriers. Considering that the carbon and coke have densities much higher than, and the resin density is closer to, that of floc biomass, differences in the settling velocities of activated sludge flocs and carrier/activated sludge flocs provide evidence of fluid flow through activated sludge flocs. (Rochester-PTT)
W89-01459

LAND FARMING OF RESERVE PIT FLUIDS AND SLUDGES: FATES OF SELECTED CONTAMINANTS,

Oklahoma State Univ., Stillwater.
For primary bibliographic entry see Field 5B.
W89-01460

WASTEWATER COLLECTION,

RJN Environmental Associates, Inc., Wheaton, IL.
A. J. Hollenbeck.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 802-804, June 1988. 43 ref.

Descriptors: *Literature review, *Wastewater treatment, *Wastewater collection, *Sewer systems, Design criteria, Management planning, Maintenance, Rehabilitation, Safety, Performance evaluation, Construction.

Literature published in 1987 on wastewater collection systems is summarized under the following headings: planning, design, and construction; sewer system evaluation; rehabilitation, safety; and maintenance/pumping. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01468

WASTEWATER TREATMENT: PHYSICAL AND CHEMICAL METHODS,

Maryland Univ., College Park. Dept. of Civil Engineering.
R. W. Walters, Z. Yousefi, A. L. Tarleton, D. Grasso, and A. Guiseppi-Elie.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 804-816, June 1988. 217 ref.

Descriptors: *Literature review, *Wastewater treatment, *Chemical treatment, *Physical wastewater treatment, Precipitation, Coagulation, Flocculation, Flotation, Adsorption, Air stripping, Ion exchange, Mixing, Separation techniques, Electrochemistry, Aeration, Corrosion, Oxidation, Reduction, Membrane processes.

Literature published in 1987 on physical and chemical methods of wastewater treatment is summarized under the following headings: innovative process technology, mixing/agitation, fluid flow, equalization/neutralization, precipitation, coagulation/flocculation, solid/liquid separation, flotation, adsorption, ion exchange, aeration/gas transfer, air stripping, mass transfer separation processes, corrosion and corrosion control, oxidation/reduction, electrochemical processes, and membrane processes. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01469

ACTIVATED SLUDGE,

State Univ. of New York at Buffalo. Dept. of Civil Engineering.
A. S. Weber, J. A. Silverstein, J. H. Sherrard, R. O. Mines, and M. S. Kennedy.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 816-824, June 1988. 128 ref.

Descriptors: *Literature review, *Activated sludge process, *Process control, *Biological wastewater treatment, *Wastewater treatment, Design criteria, Control systems, Sludge properties, Separation techniques, Industrial wastes, Activated carbon, Xenobiotic compounds, Leachates, Nitrogen, Phosphorus, Nutrient removal, Mathematical models, Adsorption.

Literature published in 1987 on activated sludge wastewater treatment is summarized under the following headings: process models; process research; design, control, performance, and operation; xenobiotic compound removal; particulate activated carbon treatment; industrial wastes; leachate; nitrogen and phosphorus; sludge characteristics; solids separation. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01470

BIOLOGICAL FIXED-FILM SYSTEMS,

New Hampshire Univ., Durham. Dept. of Civil Engineering.
N. E. Kinner, and T. T. Eighmy.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 824-828, June 1988. 72 ref.

Descriptors: *Literature review, *Biological wastewater treatment, *Fixed-film reactors, *Wastewater treatment, *Filtration, *Biofilms, Trickling filters, Aerobic digestion, Anaerobic digestion, Model studies, Activated carbon, Fluidized beds, Performance evaluation, Rotating biological contactors.

Literature published in 1987 on wastewater treatment with fixed-film reactors is summarized under the following headings: rotating biological contactors, trickling filters, biological activated carbon, biofilters, submerged filters, fluidized beds, innovative fixed-film processes, biofilm growth, biofilm models, biofilm modeling and research with experimental verification, and anaerobic and anoxic biofilm systems. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion

criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01471

LAGOONS, PONDS, AND AEROBIC DIGESTION,
C. W. Bryant.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 828-831, June 1988. 62 ref.

Descriptors: *Literature review, *Aerated lagoons, *Wastewater treatment, *Waste stabilization, *Aerobic digestion, Heavy metals, Pathogens, Performance evaluation, Design criteria, Lagoons, Stabilization lagoons, Thermophilic digestion, Ponds.

Literature published in 1987 on lagoons, ponds, and aerobic digestion for wastewater treatment is summarized under the following headings: biology, performance, aerobic digestion, and aerobic thermophilic digestion. Specific topics discussed included heavy metal removal, pathogen removal, and performance evaluation. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01472

ANAEROBIC PROCESSES,
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
S. Goodwin, and R. F. Hickey.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 831-837, June 1988. 100 ref.

Descriptors: *Literature review, *Wastewater treatment, *Anaerobic conditions, *Anaerobic digestion, *Biological wastewater treatment, *Process control, Monitoring, Toxins, Model studies, Operations, Wastewater facilities, Hydrogen ion concentration, Temperature.

Literature published in 1987 on anaerobic wastewater treatment is summarized under the following headings: microbiology; degradation of toxic compounds; inhibition of anaerobic systems; process monitoring, control, and modeling; attachment and start-up of anaerobic systems; acidogenic conversion; high-rate anaerobic reactor operation; and anaerobic digester operation. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01473

SLUDGE TREATMENT, UTILIZATION, AND DISPOSAL,
Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.
P. T. Bowen, J. M. Entwistle, J. E. Hendrick, J. S. Quillin, and U. N. Tyagi.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 837-844, June 1988. 130 ref.

Descriptors: *Literature review, *Sludge disposal, *Wastewater treatment, *Sludge utilization, *Biological wastewater treatment, *Water treatment, Sludge properties, Sludge conditioning, Sludge thickening, Sludge drying, Sludge stabilization, Sludge inactivation, Reclamation, Land application, Pathogens.

Literature published in 1987 on sludge treatment, sludge utilization, and sludge disposal is summarized under the following headings: sludge properties, thickening, conditioning, dewatering, stabilization and inactivation, ultimate disposal (reclamation, land application, and pathogens), and water treatment plant sludges. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01474

ON-SITE ALTERNATIVES FOR TREATMENT AND DISPOSAL,
ERT, A Resource Engineering Co., Concord, MA.
S. M. Pause.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 844-845, June 1988. 18 ref.

Descriptors: *Literature review, *On-site systems, *Wastewater treatment, *Wastewater disposal, *Land disposal, Animal wastes, Domestic wastes, Groundwater pollution, Design criteria, Groundwater mounds, Septic wastewater, Water pollution sources, Path of pollutants, Performance evaluation, Site selection.

Literature published in 1987 on on-site alternatives for treatment and disposal of wastewater is summarized under the following headings: pollution from on-site systems (animal wastes, domestic wastes, septic system groundwater mounds), design and siting of on-site systems, and performance of on-site systems. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01475

DISINFECTION,
Environmental Protection Agency, Cincinnati, OH.
A. D. Venosa, and R. A. Isaac.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 845-852, June 1988. 106 ref.

Descriptors: *Literature review, *Wastewater treatment, *Disinfection, *Microbiological studies, *Chemical treatment, Cooling towers, Halogens, Oxidation, Ozonation, Irradiation, Lagoons, Electric fields, Copper, Chemical analysis, Byproducts, Sanitary wastewater, Oxychlorine compounds, Ozone, Maturation ponds, Stabilization lagoons, Chemical reactions.

Literature published in 1987 on disinfection of wastewater is summarized, including microbiology and chemistry. Specific topics are halogen disinfection, oxychlorine compounds, ozone, ultraviolet light, photo-oxidation disinfection, gamma radiation for disinfection, maturation ponds, lagooning, electric fields, copper for disinfection of sanitary wastewater, disinfection of cooling towers, analytical chemistry, formation of byproducts and their control, treatment of wastes resulting from disinfection, and chemical reactions in the disinfection process. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01476

TREATMENT PLANT MANAGEMENT, OPERATION AND MAINTENANCE,
Baker/TSA, Inc., Coraopolis, PA.
G. M. Wong-Chong.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 852-854, June 1988. 56 ref.

Descriptors: *Literature review, *Management, *Operations, *Maintenance, *Wastewater facilities, Process control, Control systems, Automation, Training, Safety.

Literature published in 1987 on management, operation, and maintenance of wastewater treatment plants is summarized under the following headings: management safety and training, process operation, process maintenance, and instrumentation and automation. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01477

WASTEWATER RECLAMATION AND REUSE,
California State Water Resources Control Board, Sacramento.
For primary bibliographic entry see Field 3C.
W89-01478

LAND APPLICATION OF WASTEWATER,
ERM-Southeast, Inc., Marietta, GA.
J. Zirschky, and A. R. Abernathy.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 857-858, June 1988. 32 ref.

Descriptors: *Literature review, *Wastewater disposal, *Wastewater treatment, *Land disposal, *Biological wastewater treatment, Overland flow, Soil genesis, Phosphorus removal, Water hyacinth, Duckweed, Aquatic plants, Artificial wetlands, Nitrogen removal, Storm runoff, Aquatic plant filters.

Literature published in 1987 on land application of wastewater is summarized under the following headings: slow rate, overland flow, and miscellaneous. Specific topics include wastewater irrigation, changes in soil properties resulting from land application, phosphorus removal efficiencies, water hyacinths and duckweed for secondary treatment of wastewater, aquatic plant filters, and constructed wetlands for nitrogen removal and treatment of stormwater runoff. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01479

HEALTH EFFECTS ASSOCIATED WITH WASTEWATER TREATMENT, DISPOSAL, AND REUSE,
Alberta Univ., Edmonton. Div. of Health Services Administration.
S. E. Hrudey, and E. J. Hrudey.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 858-864, June 1988. 106 ref.

Descriptors: *Literature review, *Public health, *Wastewater disposal, *Wastewater collection, *Wastewater facilities, *Wastewater reuse, *Population exposure, Wastewater treatment, Feces, Municipal wastes, Water supply systems, Water pollution, Contamination, Industrial wastes, Hazardous wastes, Sludge handling.

Literature published in 1987 on health effects of wastewater management is summarized under the following headings: wastewater collection systems and treatment plants, sludge handling and disposal, excreta and wastewater disposal, excreta and wastewater reuse, contamination of water supplies, municipal solid wastes, and industrial and hazardous wastes. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01480

MEAT, FISH, AND POULTRY PROCESSING WASTES,
W. T. McComis, and J. H. Litchfield.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 868-870, June 1988. 37 ref.

Descriptors: *Literature review, *Food-processing wastes, *Industrial wastewater, Meat processing industry, Fish processing industry, Poultry industry, Chemical treatment, Biological wastewater treatment, Water pollution control.

Literature published in 1987 on meat, fish, and poultry processing wastes in relation to water pollution control is summarized under the following headings: meat processing, fish processing, and poultry processing. Various methods of chemical and biological treatment of these wastewaters are discussed. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01482

FRUIT, GRAIN, AND VEGETABLE WASTES,
Brigham Young Univ., Provo, UT. Dept. of Civil Engineering.
M. B. Borup, G. A. Hesketh, and J. Zirschky.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 870-872, June 1988. 31 ref.

Descriptors: *Literature review, *Food-processing wastes, *Industrial wastewater, *Wastewater treatment, *Biological wastewater treatment, Land disposal, Cost analysis, Fruit crops, Vegetable crops, Grain crops, Agricultural wastes.

Literature published in 1987 on treatment of fruit, grain, and vegetable wastewaters is summarized. Biological treatment and land disposal of these wastewaters are discussed, including costs of various alternatives. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01483

FERMENTATION INDUSTRY,
Alabama Univ. in Birmingham. School of Public Health.
J. F. Manning, and S. C. Chiesa.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 872-874, June 1988. 27 ref.

Descriptors: *Literature review, *Brewery wastes, *Distillery wastes, *Fermented products, *Wastewater treatment, *Industrial wastewater, Biological oxygen demand, Chemical oxygen demand, Pharmaceutical industry, Alcohols, Fuel.

Literature published in 1987 on management of wastes from fermentation industries is summarized under the following headings: brewery wastes, alcohol fuel production wastes, pharmaceutical production wastes, distillery wastes, and other fermentation industry wastes. Various approaches to reducing BOD and COD of these wastes are discussed. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01484

DAIRY WASTES,
R. F. Pico.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 874-876, June 1988. 20 ref.

Descriptors: *Literature review, *Dairy wastes, *Industrial wastewater, *Farm wastes, *Wastewater treatment, *Biological wastewater treatment, Case histories, Biological oxygen demand, Chemical oxygen demand, Wastewater facilities, Operations, Anaerobic digestion.

Literature published in 1987 on treatment of dairy industry wastewaters is summarized, including results of research and case histories (anaerobic biological methods of reducing BOD and COD and management of treatment plant operations). The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01485

AGRICULTURAL WASTES,
Georgia Tech Research Inst., Atlanta.
S. R. Harper, C. C. Ross, and G. E. Valentine.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 876-884, June 1988. 165 ref.

Descriptors: *Farm wastes, *Literature review, *Agricultural wastes, *Wastewater treatment, *Biological wastewater treatment, Process control, Aerobic digestion, Composting, Anaerobic digestion, Crop residues, Manure, Separation techniques, Odor control, Air pollution control, Wastewater renovation, Water reuse, Runoff control, Fertilizers, Soil properties, Aquaculture, Recycling, Waste recovery, Surveys.

Literature published in 1987 on management of wastewaters from agriculture is summarized, including the following: regional/international waste surveys, agricultural waste characteristics, agricultural wastewater treatment (aerobic digestion and composting), anaerobic treatment (crops and crop residues, cattle manure and mixtures, swine manure, poultry manure, and modeling and process control), miscellaneous treatment considerations (solid/liquid separation, odor and air quality control, and runoff and runoff control), water recycle and reuse (fertilizers and soil conditioners), aquaculture, and use of wastes (animal feeds, chemical feedstocks, combustion, and manufacturing and construction materials). The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01486

TEXTILE WASTES,
ERT, A Resource Engineering Co., Concord, MA.
K. A. Groff, and B. R. Kim.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 884-886, June 1988. 42 ref.

Descriptors: *Literature review, *Textile industry, *Industrial wastes, *Wastewater treatment, *Biological wastewater treatment, Chemical treatment, Recycling, Waste recovery, Water pollution control.

Literature published in 1987 on textile wastes in relation to water pollution control is summarized under the following headings: biological treatment, physical and chemical treatment, and recycle and recovery. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01487

PETROLEUM PROCESSING AND SYNTHETIC FUELS,
Scholler, P.O. Box 26968, Philadelphia, PA 19134.
B. W. Cowan, J. A. Thomas, and E. L. Stover.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 890-893, June 1988. 71 ref.

Descriptors: *Literature review, *Oil industry, *Industrial wastes, *Fuel, *Wastewater treatment, *Water pollution control, Air flotation, Anaerobic digestion, Biodegradation, Oil shale, Wastewater analysis, Waste recovery, Toxicity, Coal conversion, Solid wastes, Leaching.

Literature published in 1987 on petroleum processing and synthetic fuel manufacturing from the perspective of water pollution control is summarized. Topics include: biodegradation of petroleum wastes, dissolved air flotation, anaerobic digestion, land treatment for biodegradation of petroleum wastes, oil shale waste characteristics, toxicity of synfuels wastewater plant emissions, biodegradation of constituents of coal conversion wastewaters, and leaching behavior and reuse of coal gasification solid wastes. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01489

METAL FINISHING AND PROCESSING,
CH2M/Hill, Reston, VA.
T. E. Higgins, and D. P. Desher.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 904-909, June 1988. 86 ref.

Descriptors: *Literature review, *Metal-finishing wastes, *Industrial wastewater, *Wastewater treatment, Regulations, Heavy metals, Waste recovery, Waste minimization, Sludge, Cyanide.

Literature published in 1987 on metal finishing and processing wastes in relation to water pollution control is summarized under the following headings: regulatory aspects, heavy metal treatment, waste minimization and metal recovery techniques, sludge management, and cyanide treatment. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01491

CHEMICALS AND ALLIED PRODUCTS,
Union Carbide Corp., South Charleston, WV.
M. P. del Pino, and R. L. Blessing.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 909-916, June 1988. 116 ref.

Descriptors: *Literature review, *Chemical industry, *Fate of pollutants, *Wastewater treatment, Solute transport, Water pollution effects, Toxicity, Aquatic organisms, Model studies, Aerobic digestion, Anaerobic digestion, Ozonation, Ultraviolet radiation, Separation techniques, Membrane processes, Land disposal, Waste disposal, Biological wastewater treatment, Land disposal, Sludge management.

Literature published in 1987 on chemicals and allied products in relation to water pollution control is summarized under the following headings: environmental fate and effect (environmental regulations, transport/transformation, and aquatic toxicity), biological treatment (modeling, aerobic treatment, and anaerobic treatment), physical chemical treatment (air stripping, activated carbon treatment, ozone/ozone-UV treatment, and membrane separation), land treatment/disposal, and sludge/residue management. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selec-

tions were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01492

SOLID AND HAZARDOUS WASTES AND WATER QUALITY,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-01494

PURIFICATION OF DOMESTIC WASTEWATER BY THREE PLANTINGS OF HELIOPHYTES AND A MICROPHYTE LAGOON UNDER THE SAME TEMPERATURE CLIMATE (EPURATION COMPAREE DES EAUX USEES DOMESTIQUES PAR TROIS PLANTATIONS HELIOPHYTIQUES ET PAR UN LAGUNAGE A MICROPHYTES SOUS UN MEME CLIMATE TEMPERE),
Fondation Univ. Luxemborgeoise, Arlon (Belgium).
M. Radoux, and D. Kemp.
Acta Oecologica, Oecologica Applicata AOSADN, Vol. 9, No. 1, p 25-38, 1988. 7 fig, 1 tab, 17 ref. English summary.

Descriptors: *Wastewater treatment, *Pollution load, *Heliophytes, *Macrophytes, *Biological wastewater treatment, Municipal wastewater, Lagoons, Nitrogen, Phosphorus, Chemical oxygen demand, Water pollution, Pollutants, Domestic water.

The purification efficiency of four small wastewater treatment systems (three cultures of helophytes--Typhalatifolia, Iris pseudacorus, Epilobium hirsutum,--and a microphyte lagoon) was studied during the second and third year of functioning with an exclusive supply of domestic wastewater. Each system consisted of four basins on four successive levels. The load of pollution corresponded, in all cases, to one inhabitant-equivalent per 6 sq m. Water pollution removal by the different systems was estimated for the following parameters: total chemical oxygen demand (COD), suspended solids (SS), total nitrogen and total phosphorus. The results showed that the microphyte lagoon was less efficient than the macrophyte plantations for COD and SS retention. The Typha and Iris populations increased the purification efficiency for total nitrogen and total phosphorus while the Epilobium system was less efficient than the lagoon in winter for these parameters. Water purification by all systems showed cyclical variations. These cycles were more or less marked and regular depending on the system concerned, the pollution parameter considered, the climate, or the features of the polluted input water. (Author's abstract)
W89-01524

TREATMENT AND DISPOSAL TECHNOLOGIES FOR LIQUID HAZARDOUS WASTES ALTERNATIVES TO SUBSURFACE INJECTION,
Engineering-Science, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5E.
W89-01594

ECONOMIC IMPACTS OF ALTERNATIVE TECHNOLOGIES FOR TREATMENT AND DISPOSAL OF LIQUID HAZARDOUS WASTES,
Engineering-Science, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5E.
W89-01595

SUPERCRITICAL DEEP WELL WET OXIDATION OF LIQUID ORGANIC WASTES,
Vertox, Inc., Dallas, TX.
J. M. Smith, and T. J. Raptis.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 715-732, 5 fig, 5 tab, 10 ref.

Descriptors: *Organic wastes, *Injection wells, *Disposal wells, *Oxidation, *Wastewater disposal, *Wastewater treatment, Deep wells, Hazardous wastes, Domestic wastes, Waste disposal, Industrial wastes, Waste management, Costs, Deep well reactors.

The concept and practice of wet oxidation of organic waste materials is well established in the United States. The Zimpro process, based on the early work of Zimmerman has been practiced in the U.S. since the early 1960's for the conditioning and oxidation of municipal sludge. The use of the deep well process configuration as a more satisfactory and economical engineering approach to the application of wet oxidation concepts for municipal wastewater treatment wastes began in 1975 with the U.S. EPA support of the Vertical Tube Reactor project in Longmont, Colorado. The history of the development of subcritical deep well oxidation technology from 1975 through 1985 is reviewed, and an important extension of this technology to achieve supercritical oxidation of municipal, industrial and hazardous waste in a deep well reactor is described. Supercritical water chemistry is briefly described along with the particular advantages of the deep well reactor configuration for achieving the necessary reactor conditions for destruction of toxic and hazardous wastes. The supercritical deep well reactor technology is at an early stage of development. The process has been shown to be fundamentally sound and to offer the industrial community of the U.S. a heretofore unrecognized alternative to present day means of liquid organic industrial and hazardous waste disposal. Cost projections suggest a total off-site treatment cost of from $0.05 to $0.15 gallon and an on-site cost of $0.02 to $0.5 gallon. (See also W89-01564) (Author's abstract)
W89-01596

PRINCIPLES OF BIORECLAMATION OF CONTAMINATED GROUND WATER AND LEACHATES,
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-01644

WASTE IMMOBILIZATION IN CEMENT-BASED GROUTS,
Oak Ridge National Lab., TN. Chemical Technology Div.
For primary bibliographic entry see Field 5E.
W89-01651

PROCESS TECHNOLOGY FOR THE BIOLOGICAL TREATMENT OF TOXIC ORGANIC WASTES,
Delaware Univ., Newark. Dept. of Civil Engineering.
A. F. Rozich, and A. F. Gaudy.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 319-333, 6 fig, 2 tab, 12 ref.

Descriptors: *Waste disposal, *Biodegradation, *Organic wastes, *Wastewater treatment, *Biological wastewater treatment, *Hazardous wastes, *Toxic wastes, Kinetics, Activated sludge process, Biomass, Aerobic digestion.

The results of several years' work on the aerobic biological treatment of toxic organic wastes is presented. Based on this work, a number of engineering strategies applicable to the biological treatment of inhibitory organic compounds are suggested. The kinetics of microbial growth on toxic, or inhibitory wastes and on nontoxic, or conventional wastes are compared and contrasted by illustrating both the differences and similarities with the biodegradation kinetics of these different types of wastes. It is essential to characterize the nature of microbial growth kinetics on a particular waste in order to recommend relevant treatment models for designing and operating effective treatment facilities. A key requirement for the design and operation of biological treatment facilities is to have a relatively accurate assessment of both the range and variability of the biokinetic constants that characterize the biomass that is responsible for purification of a particular waste. These constants can be classified as the biokinetic growth constants and the maintenance constants. The latter group is responsible for quantifying sludge production in a biological treatment system while the former group quantifies the relationship between biomass growth rate and exogenous substrate (waste) concentration. Methods for evaluating the maintenance constants are relatively straightforward and are the same for both inhibitory and noninhibitory wastes. The situation is different, however, for the biokinetic growth constants. For noninhibitory wastes, only two biokinetic constants are used in the growth rate function, whereas for inhibitory wastes, three biokinetic growth constants are used. A number of methodologies are presented that can be used for collecting growth data and for evaluating the biokinetics constants for acclimated populations growing on inhibitory compounds. The development and application of design and operating equations that can be used for activated sludge processes treating toxic wastes are discussed. (See also W89-01634) (Author's abstract)
W89-01652

TRADEOFFS BETWEEN STREAM REGULATION AND POINT SOURCE TREATMENTS IN COST-EFFECTIVE WATER QUALITY MANAGEMENT,
Tennessee Valley Authority, Norris. Water Systems Development Branch.
For primary bibliographic entry see Field 5G.
W89-01758

WASTEWATER DISINFECTION,
Water Pollution Control Federation, Alexandria, VA.
Manual of Practice No. FD-10. Water Pollution Control Federation, Alexandria, Virginia. 1986. 165p.

Descriptors: *Wastewater treatment, *Disinfection, Manuals, Chlorination, Chlorine dioxide, Bromine chloride, Ultraviolet light, Ozonation.

This manual is the culmination of the combined efforts of the Water Pollution Control Federation's Wastewater Disinfection and Technical Practice Committees to provide comprehensive information on the disinfection of municipal wastewaters. It covers chlorination, as well as the major alternatives to chlorination: ozone, chlorine dioxide, bromine chloride, and ultraviolet light. The goal is to provide operations personnel, design engineers, and regulatory officials with a reference of current disinfection practices. No attempt is made to compare different treatment methods. Rather, the aim is to provide factual evidence concerning the useful applications of each method. (Lantz-PTT)
W89-01819

OPERATION OF EXTENDED AERATION PACKAGE TREATMENT PLANTS,
Water Pollution Control Federation, Alexandria, VA.
Manual of Practice No. OM-7. Water Pollution Control Federation, Washington, DC. 1985. 95p.

Descriptors: *Aeration, *Wastewater treatment, *Wastewater facilities, Biological treatment, Wastewater management, Monitoring.

Thousands of small package extended aeration wastewater treatment plants are currently in operation throughout the world. Many of these plants are operated by individuals with little formal training or experience in the wastewater treatment field. This manual aims to provide a plain language or nontechnical explanation of the operation of a package extended aeration treatment plant. Where equations or technical terms are required, explanations in plain language follow. This manual is for the operator who has completed grades 8 through 12, who is operating a treatment plant with a design flow of up to 5 liters per second (100,000

gallons per day), generally without a laboratory or operating building on site, and whose vehicle serves as an office. This manual should be used in conjunction with the manufacturer's Operations and Maintenance (O and M) manual, because each O and M manual will be specific for a particular plant and will usually list a maintenance schedule for various parts of the system. (Lantz-PTT)
W89-01820

PRIME MOVERS ENGINES, MOTORS, TURBINES, PUMPS, BLOWERS AND GENERATORS.
Water Pollution Control Federation, Alexandria, VA.
For primary bibliographic entry see Field 8C.
W89-01821

ECOLOGICAL CONSIDERATIONS IN WETLANDS TREATMENT OF MUNICIPAL WASTEWATERS.
Van Nostrand Reinhold Company, New York. 1985. 473p. Edited by Paul J. Godfrey, Edward R. Kaynor, Sheila Pelczarski, and Jay Benforado. Contract No. RFP FWS-9-82-001.

Descriptors: *Land treatment, *Wetlands treatment, *Municipal wastewater, *Wetlands, *Wastewater treatment, *Ecological effects, Ecosystems, Public health, Water pollution effects, Case studies, Nutrients, Hydrology.

Thirty-one papers are presented within the format of seven topical 'sessions' and an eight session that attempts to pull together and synthesize the diverse findings and conclusions of the conference. Session I deals with state-of-the-art engineering applications of wastewater to wetlands. Session II deals with the multiplicity of environmental values and perspectives that must be considered. Session III shifts the emphasis to specifics of ecosystem dynamics, particularly the interaction between hydrology and nutrients. Session IV addresses the general topic of possible wetland community changes resulting from wastewater applications. Session V focuses on environmental health problems for humans and wildlife that could result from accumulations of pathogens or toxic materials. Session VI considers the question of long-term effects by examining several case histories of wetlands that have received wastewater or simulated wastewater and have been studied for many years. Session VII returns in part to engineering considerations by addressing the topic of wetland management potential. Session VIII attempts to synthesize the varying points of view and scientific documentation contained in the papers of the preceding sessions. (See W89-01828 thru W89-01858) (Lantz-PTT)
W89-01827

WETLAND SYSTEMS FOR WASTEWATER TREATMENT: ENGINEERING APPLICATIONS,
Ramlit Associates, Inc., Berkeley, CA.
N. N. Hantzsche.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 7-25, 4 tab, 37 ref.

Descriptors: *Wastewater treatment, *Wetlands treatment, Geohydrology, Ecology, Environmental effects, Agriculture, Storm water, Industrial wastewater, Process control, Artificial wetlands.

The use of wetlands for treatment of various wastewaters has attracted considerable interest and research attention during the past 10 to 15 years. What can generally be concluded on the basis of the experience to date is that: (1) Wetland systems can provide measurable renovation of wastewaters and storm waters, but the necessary understanding and criteria to take the best advantage of these processes on a routine basis do not currently exist; (2) Natural wetlands are highly variable in characteristics, making it difficult, if not impossible, to apply study results to different geographical areas; (3) The use of artificial or constructed wetlands appears to have the greatest promise for general application because of better reliability and process control; (4) There is a substantial amount of interest in creating or restoring wetlands simply for environmental enhancement. There are also strong desires to couple environmental enhancement with programs for treatment of municipal wastewaters, stormwaters, agricultural return flows, and various types of industrial wastewaters; and (5) Pilot or demonstration studies are still needed before engineers can confidently proceed with design and implementation of full-scale wetland-wastewater systems. (See also W89-01827) (Lantz-PTT)
W89-01828

DESIGN AND USE OF ARTIFICIAL WETLANDS,
Ontario Ministry of the Environment, Toronto. Policy and Planning Branch.
For primary bibliographic entry see Field 2H.
W89-01829

MOSQUITO CONSIDERATIONS IN THE DESIGN OF WETLAND SYSTEMS FOR THE TREATMENT OF WASTEWATER,
Dewante and Stowell, Sacramento, CA.
R. Stowell, S. Weber, G. Tchobanoglous, B. A. Wilson, and K. R. Townzen.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 38-47, 5 fig, 1 tab, 5 ref.

Descriptors: *Mosquitoes, *Wetlands treatment, *Artificial wetlands, *Wastewater treatment, *Water hyacinth, Costs, Economic aspects, Pretreatment of wastewater, Plug flow, Insect control.

In the Central Valley of California, water hyacinth systems have produced year-round an effluent containing consistently < 10 mg/L of biochemical oxygen demand (BOD) and 10 mg/L of suspended solids (SS) at costs substantially lower than other technologies, including overland flow. Recently, several local hyacinth systems have been taken out of service because of mosquitoe production problems, the major drawback of the systems. Mosquito-production research data from the Roseville, California, hyacinth systems is presented. Ways to minimize hyacinth-system mosquito production by design are discussed and design strategies for hyacinth and other wetland-type systems. The wetlands options for new (pretreatment, plug flow reactor design) or existing (secondary sedimentation, plug flow reactor design) wastewater treatment systems represent a departure from what has been done in the past. The documented performance and lower cost of these systems make it clear that where the conditions are suitable, these systems should be considered in any cost-effective analysis of wastewater treatment alternatives. However, before the widespread use of wetland wastewater treatment systems can be recommended routinely, research and surveillance of additional pilot projects are needed to determine the mosquito-production potential of wetland systems as a function of design, operation, and mosquitoe-abatement measures. (See also W89-01827) (Lantz-PTT)
W89-01830

CONSIDERATIONS FOR WETLAND TREATMENT OF SPENT GEOTHERMAL FLUIDS,
CH2M, Inc., Portland, OR.
V. W. Kaczynski.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 48-65, 2 fig, 4 tab.

Descriptors: *Wastewater treatment, *Wetlands treatment, *Geothermal wastes, Water pollution effects, Industrial wastewater, Toxicity, Environmental effects, Ecological effects, Site selection, Design standards.

Most wetlands treatment studies have dealt with the disposal of partially treated municipal sewage effluent; industrial applications are not common. A generic research study was recently performed that investigated the feasibility of disposing spent industrial geothermal fluids by wetlands treatment. The main objectives of this paper are: (1) to present two sets of ecological criteria for effluent application in wetlands in order to discuss their appropriateness (especially in terms of industrial effluents or municipal effluents with major industrial contributors that do not have pretreatment programs) and (2) to present some general design environmental effects, and ecological factors associated with selecting sites and designing wetlands for effluent treatment. The reference studies were directed primarily toward creating and managing wetlands as alternative treatment systems, with secondary objectives of providing waterfowl and wildlife habitat. These studies were done mainly in relatively water-short western areas. (See also W89-01827) (Lantz-PTT)
W89-01831

ECOLOGICAL PERSPECTIVES ON WETLAND SYSTEMS,
Wisconsin Univ.-Milwaukee. Dept. of Botany.
For primary bibliographic entry see Field 2H.
W89-01832

WATER CONSERVATION WETLAND VALUES,
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
For primary bibliographic entry see Field 2H.
W89-01833

ENERGY FLOW IN WETLANDS,
Massachusetts Univ., Amherst. Dept. of Forestry and Wildlife Management.
J. T. Finn.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 112-126, 13 fig, 13 ref.

Descriptors: *Wetlands treatment, *Wastewater treatment, *Mathematical models, *Energy flow, *Wetlands, *Ecosystems, Energy, Carbon, Barataria Bay, Flow pattern, Marshes, Fate of pollutants.

The ecosystem dynamics unique to each wetland pose the difficult problem of predicting the impacts of management for treatment of municipal wastewater so that undesirable changes may be avoided. Few of the available analytical tools will permit the evaluation of wetlands models or the general prediction of the consequences of wetland modification. An analytical technique called flow analysis is proposed as a method for such evaluations. Demonstrations illustrate the types of information that can be gained from analysis of energy and carbon (C) flow in two wetlands. Flow analysis allows dissection of complex flow networks, so that flows from a particular compartment to any other compartment can be analyzed. In analyzing wetlands energy-flow models, indirect flows are often more important than direct flows. Moreover, energy cycling can be an important component of indirect energy flow. Flow analysis can also provide estimates of the timing of flows -- that is, how long it takes for energy to get from organism A to organism B. In Barataria Bay, for example, an increase in primary production would still have large effects on marsh detritus three years later and on aquatic fauna four years later. Maximum effect on marsh detritus would be expected in year one, and on aquatic fauna in year two. The exact timing of impact effects cannot be determined without a time series of measurements or a simulation model because flow structure will change, but these approximations will be close. Finally, flow analysis can also be used to address questions of elemental cycling and toxin fate. For both elements and toxins, indirect effects are much more important than for energy. (See also W89-01827) (Lantz-PTT)
W89-01834

WASTEWATER INPUT TO COASTAL WETLANDS: MANAGEMENT CONCERNS,
San Diego State Univ., CA. Dept. of Biology.
J. Zedler.

IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 127-133, 2 fig, 1 tab, 3 ref.

Descriptors: *Wetlands treatment, *Wastewater treatment, *Wetlands, *Wastewater disposal, *Coastal marshes, Ecosystems, Environmental protection, Species diversity, Ecology, Marshes, Environmental policy.

In a region where coastal wetlands have declined to 10% to 25% of their natural extent, there are concerns that freshwater-dominated ecosystems should not replace the remaining native salt-marsh communities. With large-scale recycling of imported water, there would be major changes in the region's hydrology, and coastal wetlands would ultimately receive substantially larger volumes of freshwater throughout the year. This potential threat to coastal ecosystem structure and functioning could be reduced if the location, amounts, and timing of discharge were properly controlled. It could be made advantageous to coastal-wetland restoration efforts if the discharges were directed toward establishing marsh vegetation, restoring brackish and freshwater marshes, and increasing habitat diversity. Creative management, at the watershed level, should turn a potential problem into a solution for southern California's endangered coastal wetlands. (See also W89-01827) (Lantz-PTT)
W89-01835

COMPARISONS OF THE PROCESSING OF ELEMENTS BY ECOSYSTEMS, I: NUTRIENTS,
Cornell Univ., Ithaca, NY. Ecosystems Research Center.
For primary bibliographic entry see Field 2H.
W89-01836

COMPARISONS OF THE PROCESSING OF ELEMENTS BY ECOSYSTEMS, II: METALS,
Marine Biological Lab., Woods Hole, MA.
A. E. Giblin.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 158-179, 7 fig, 3 tab, 66 ref.

Descriptors: *Wastewater treatment, *Fate of pollutants, *Metals, *Wetlands treatment, Heavy metals, Land disposal, Lead, Cadmium, Zinc, Geochemistry, Wastewater disposal.

Metal-budget and metal-flux data for wetland ecosystems show that the percentage of metal removed by passage through the ecosystem varies widely between metals and among wetlands. While some metals, such as Pb, may be well retained by wetlands under conditions of low loading rates, the majority of metals, such as Zn and Cd, may pass through the ecosystem. Although in a geochemical sense, wetlands are 'sinks' for some metals, these studies indicate that they may not function as efficient 'traps' for all metals. By better understanding the biogeochemical processes that alter metal retention, it may be possible to manipulate wastewater release to maximize metal removal in natural and artificial wetlands. Previous studies have shown that some of the assumptions that have been made in order to construct metal budgets may not be true, and improved budgets could yield a more accurate picture of what is occurring. Analytical techniques for measuring metals have improved tremendously in the last ten years, and complete budgets by input/output studies are now possible in ecosystems where accurate water budgets can be constructed. (See also W89-01827) (Lantz-PTT)
W89-01837

EFFECT OF NATURAL HYDROPERIOD FLUCTUATIONS ON FRESHWATER WETLANDS RECEIVING ADDED NUTRIENTS,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
S. E. Bayley.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 180-189, 2 fig, 3 tab, 5 ref.

Descriptors: *Wetlands treatment, *Wastewater treatment, *Nutrients, *Land disposal, *Wastewater disposal, Nitrogen, Phosphorus, Vegetation, Marshes, Chemical analysis, Bioaccumulation.

A study was conducted of wastewater application to a wetland in Claremont, florida. The objectives were to determine the effects of a fluctuating water table on the retention of N and P from treated sewage effluent by the marsh system and its various components (vegetation, soil, and water). The marshes removed both N and P during wet and dry years. Only at the highest level of effluent application (9.6 cm/week) could any differences be detected in vegetation or snil chemistry due to the effluent. Plots receiving 1.5 cm/week and 3.7 cm/week of effluent could not be distinguished from the control plot. While the species composition changed with the addition of effluent, it also changed as a result of marsh-water levels. Vegetative growth rates, standing crop, and P tissue content were influenced as much by the presence of standing water as they were by the application of 9.6 cm/week treated effluent. N tissue concentrations were more related to the effluent application than to the water levels. (See also W89-01827) (Lantz-PTT)
W89-01838

SIGNIFICANCE OF HYDROLOGY TO WETLAND NUTRIENT PROCESSING,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
H. Hemond, and W. Nuttle.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 190-195, 2 fig.

Descriptors: *Wetlands treatment, *Wastewater treatment, *Nutrients, Hydrology, Cycling nutrients, Groundwater movement, Mathematical studies.

In many wetland ecosystems, the major nutrient processing occurs at or beneath the surface of the sediment. Accordingly, to understand nutrient processing by a wetland ecosystem, the manner in which nutrients reach the below ground sites of processing and the manner in which products of nutrient processing may possibly be removed from the sediments and exported must be understood. Below ground processes in wastewater treatment include uptake by microbes or macrophyte roots, cation exchange, adsorption, dissimilatory reduction by microbes, biologically mediated or chemical oxidation, and a variety of other decomposition processes; in all cases, the processes occur only after the chemicals have been physically carried to the active sites. The major mechanisms of transport are two -- namely, active transport by plants and physical transport by water movement. The physical transport by water movement method is the focus of this brief paper. (See also W89-01827) (Lantz-PTT)
W89-01839

EFFECTS OF WASTEWATER ON WETLAND ANIMAL COMMUNITIES,
Lake Michigan Federation, Chicago, IL.
For primary bibliographic entry see Field 5C.
W89-01840

TERRESTRIAL COMMUNITIES: FROM MESIC TO HYDRIC,
Bowling Green State Univ., OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5E.
W89-01841

VEGETATION IN WETLANDS RECEIVING SEWAGE EFFLUENT: THE IMPORTANCE OF THE SEED BANK,
Smithsonian Environmental Research Center, Edgewater, MD.
D. F. Whigham.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 231-240, 2 fig, 2 tab, 29 ref.

Descriptors: *Wetlands treatment, *Wastewater disposal, *Vegetation, Seeds, Productivity, Model studies, Flooding, Biomass, Salt marshes, Coastal marshes, Bogs, Standing waters.

Models have been proposed for studying changes in wetland vegetation that is based on three life-history attributes: (1) life span, (2) propagule longevity, and (3) propagule establishment requirements. The model assumes that knowledge of these attributes for species in a wetland would enable one to predict vegetation composition under various hydrologic (and other environmental conditions). The effects that wastewater application might have on wetland vegetation are discussed. Because two of the three attributes used in van der Valk's model relate to the seed bank, the paper focuses primarily on the effects that altered hydrologic and nutrient patterns have on recruitment from the seed bank. Wastewater application would most likely increase the depth of flooding, duration of flooding, and/or frequency of flooding. In addition, there would be significant increases in nutrient loading. Nutrient additions have been shown to cause increased biomass production in both coastal salt marshes and the following inland freshwater wetlands: herbaceous wetlands and cypress domes in Florida; bogs in Michigan, and artificial wetlands in New York. Production did not increase in a freshwater tidal wetland receiving chlorinated, secondarily treated wastewater. The seed bank would be expected to become less important in wetlands where the hydrology is altered and permanent standing water conditions are created. By maintaining permanent standing water, all species that require a drawdown for establishment could be eliminated. There would probably be no change in the importance of the seed bank in wetlands where seeds are of minor importance (e.g., salt marshes, northern bogs, and wetlands that are permanently flooded). (See also W89-01827) (Lantz-PTT)
W89-01842

MICROBIOLOGICAL STUDIES OF MUNICIPAL WASTE RELEASE TO AQUATIC ENVIRONMENTS,
Maryland Univ., College Park. Dept. of Microbiology.
D. J. Grimes.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 270-276, 4 fig, 10 ref.

Descriptors: *Wetlands treatment, *Microbiological studies, *Wastewater disposal, *Municipal wastewater, *Wetlands, Bacteria, Pathogens, Path of pollutants, Floods, Aquatic environment, Public health.

Studies on the disposal of municipal wastes to aquatic environments have shown that both human pathogens and fecal indicator bacteria can survive in water for a long time. Many bacteria are able to survive, even to grow, in sediments. Sedimented bacteria are subject to resuspension by a variety of physical forces, including wave action, animal disturbance, swimming, and dredging. A study of the disposal of pharmaceutical wastes in the Atlantic Ocean near Puerto Rico shows that rather than settling into deep water, the effluent tends to move toward the northern shore of Puerto Rico. These data are all from environments that have currents or wave action to dilute and dissipate many of the entering pollutants, including bacteria. Wetlands do not have this advantage. Accordingly, introduction of improperly treated wastes could have severe deleterious impacts on the health status of such wetlands. Both pathogenic bacteria and the nutrients to support those bacteria could accumulate, thereby creating a disease reservoir. (See also W89-01827) (Lantz-PTT)
W89-01845

MICROBIAL TRANSFORMATIONS OF DETRITAL CARBON IN WETLAND ECOSYSTEMS: EFFECTS OF ENVIRONMENTAL STRESS,

Georgia Univ., Athens. Dept. of Microbiology.
R. E. Hodson, A. E. Maccubbin, R. Benner, and R. E. Murray.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 277-297, 7 fig, 5 tab, 29 ref. NSF Grants OCE-8117834, BSR-8114823, BSR-8215587, and OWRT Grant NA8OAA-D-00091.

Descriptors: *Wetlands treatment, *Environmental stress, *Biodegradation, *Microbiological studies, *Wetlands, *Carbon, *Stress, Detritus, Environmental effects, Vegetation, Lignin, Cellulose, Model studies, Okefenokee Swamp.

A significant percentage of the detrital-derived carbon is assimilated into microbial biomass. In this way, the plant detritus, much of which is indigestible to animals in its original fibrous form, is converted to highly nutritive compounds that can be easily digested by detritivores. Thus, microbial degradation of detritus serves as an important link between primary and secondary production in wetlands. In general, water-soluble, leachable compounds in the vascular plant detritus decompose rapidly, leaving a residue of fibrous material that is more resistant to degradation. The refractory fraction of plant materials from a number of species of wetland plants have been found to consist primarily of lignocellulose, a macromolecular complex consisting of polysaccharides (cellulose and hemicellulose) and lignin in intimate physical and probably covalent contact. Lignocellulose accounts for between 50% and 90% of the plant dry weight. Any event, natural or anthropogenic, that alters the rate of transformation of lignocellulose in a wetland will eventually affect the abundance, diversity, and production at higher trophic levels as well. A model was derived from results of studies in several wetlands as well as from analogous studies of terrestrial ecosystems. It can serve as a working hypothesis in the design of experiments. Using this hypothetical model, methodologies are being formulated for assessing rates of transformation of both the labile and refractory components of wetland plant material. The approach used, and results obtained from experiments conducted in Georgia salt marshes and in a freshwater environment, the Okefenokee Swamp are described. (See also W89-01827) (Lantz-PTT)
W89-01846

SOME LONG-TERM CONSEQUENCES OF SEWAGE CONTAMINATION IN SALT MARSH ECOSYSTEMS,

Marine Biological Lab., Woods Hole, MA.
For primary bibliographic entry see Field 5C.
W89-01847

MISSISSIPPI RIVER DELTA: A NATURAL WASTEWATER TREATMENT SYSTEM,

Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
J. G. Gosselink, and L. Gosselink.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 327-337, 4 fig, 3 tab, 19 ref.

Descriptors: *Wetland, *Wetlands treatment, *Mississippi River, *Wastewater treatment, *Deltas, Nutrients, Coastal waters, Sediments, Marshes, Inorganic compounds, Ecological effects.

An investigation was conducted to determine if the Mississippi River Delta system is an analog for municipal overland flow treatment systems and if insights from the river can be applied to human-engineered systems. The Mississippi River Delta does capture nutrients, and in significant quantities. The key to permanent, long-term retention of nutrients is accretion. In the Mississippi River Delta, accumulation can occur only because the coast is subsiding and the accretion rate is consequently high (1 cm/yr). In the Mississippi River Delta, the quantity of nutrients retained is related both to the inorganic sediment input and to the contact time of the flooding water with marsh surface. The role of inorganic sediments may be simply to act as a filter reservoir that retains the nutrients. On a regional scale and long timeframe, the Mississippi River invades an area, trap nutrients and sediments as it grows, then abandons the site and starts over again elsewhere. The old delta continues to function as it deteriorates, to support coastal geologic and biologic processes by a slow release of the sequestered sediments and nutrients. Finally, for Mississippi River Delta residents, there appear to be many opportunities for natural wetland wastewater treatment. Interior marshes in Louisiana need more sediments and nutrients since they are not presently maintaining themselves against the high rate of coastal subsidence. The state has ambitious plans to nourish these marshes by diverting fresh river water into them. (Several potential sites are close to New Orleans). Perhaps these diversions can be engineered with wastewater disposal for combined water treatment-marsh regeneration schemes. (See also W89-01827) (Lantz-PTT)
W89-01849

AGING PHENOMENA IN WASTEWATER WETLANDS,

Michigan Univ., Ann Arbor. Dept. of Chemical Engineering.
R. H. Kadlec.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 338-347, 3 fig, 8 ref. EPA Contract CR 807541-01-0.

Descriptors: *Path of pollutants, *Wastewater treatment, *Wetlands, *Wetlands treatment, Mathematical equations, Mathematical studies, Nutrients, Infiltration, Sorption, Biodegradation, Houghton Lake.

The treatment of wastewater by overland flow through a wetland has become a topic of scientific study during the last decade. The prediction of the performance of a wetland treatment facility requires equations that describe both the response of the ecosystem to wastewater additions and the alteration of water quality. Removal of dissolved nutrients from surface waters is controlled by a two-step process: delivery and consumption. Delivery is accomplished by convective mass transfer within surface waters, overland flow, or by downward flow due to water infiltration. Consumption occur principally at the surfaces of the soil, litter, plant stems, and algal mat. Two regimes will exist in a wastewater wetland system for each wastewater component considered. In the vicinity of the wastewater discharge, a saturated region will exist. Here, component removal rates will be quite slow, and a function of the uptake rates, due to: (1) sorption deep in the soil column; (2) incorporation of material into new soil and woody plants; and (3) microbial release of gases to the atmosphere. Outside this saturated region, surface-water concentrations of wastewater components will drop exponentially with distance. System parameters were estimated for operation of the Houghton Lake treatment site. Utilizing a mass balance equation formulated in this study, the predicted nitrogen-front progression was calculated. The expansion of the saturated zones about the discharge point have been found to be much as predicted by the material balance, considering only the principal mechanisms. The aging of the Houghton Lake, Michigan, site can so far be described by this model. (See also W89-01827) (Lantz-PTT)
W89-01850

ECOLOGICAL ANALYSIS OF WASTEWATER MANAGEMENT CRITERIA IN WETLAND ECOSYSTEMS,

Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
C. J. Richardson, and D. S. Nichols.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 351-391, 7 fig, 9 tab, 117 ref.

Descriptors: *Ecological effects, *Wastewater treatment, *Wetlands treatment, *Management planning, *Secondary wastewater treatment, *Wastewater management, Hydrology, Cycling nutrients, Biodegradation, Productivity, Heavy metals, Nitrogen, Phosphorus, Biological oxygen demand, Organic compounds.

A series of ecological management criteria should be addressed prior to the decision to use any wetland ecosystem for treatment of secondary municipal effluent. These criteria include the value of the effluent as a resource, the capacities and limitations of wetlands to accomplish wastewater treatment, wastewater management objectives, wastewater suitability for wetland discharge, and wetland values. Also presented are discussions of wetland hydrology, productivity, cycling of nutrients and heavy metals, and estimates of efficiencies of wastewater nutrient removal by wetlands and the wetland area needed for specific levels of nutrient removal. The key to utilizing any wetland ecosystem for N, P, BOD, and organic removal is low loading rates coupled with sufficient wetland area. A minimum of 1 ha/60 people is suggested for a 50% removal efficiency of N and P. (See also W89-01827) (Lantz-PTT)
W89-01851

ECOLOGICAL EVALUATION PROCEDURE FOR DETERMINING WETLAND SUITABILITY FOR WASTEWATER TREATMENT AND DISCHARGES,

Southeast Wisconsin Regional Planning Commission, Waukesha.
D. M. Reed, and T. J. Kubiak.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 392-404, 2 fig, 26 ref.

Descriptors: *Ecosystems, *Wetlands, *Wastewater treatment, *Guidelines, *Wetlands treatment, Wisconsin, Classification, Environmental protection.

Determinations of quality ratings for plant and animal communities within a wetland are often based on the individual opinions of the biologist reviewing the site. The degree of subjectiveness can be reduced, however, by using plant community assessments, such as the one in which the wetland quality is a measure of the diversity of plant and animal species present, the structure and integrity of the plant community, and the extent of human disturbance. Also to be considered is the commonness of the particular wetland community within the area or in the presettlement vegetation; for example, a measures of the amount of cover type as compared to the total and the diversity of plant communities and other natural features occurring within the subject wetland. On the basis of these criteria, wetlands can be ranked and classified. For example, natural areas, including wetlands in many Wisconsin counties, have been ranked and classified as follows: (1) State Scientific areas; (2) Natural Areas of Statewide or Greater Significance; (3) Natural Areas of Countywide or Regional Significance; and (4) Natural History Areas. Despite the recognition that there is an established institutional framework to evaluate wastewater discharges into wetlands, little in the way of formalized criteria to either evaluate wetlands as wastewater receiving waters or provide reasonable protection of important wetland values have been developed. Such criteria need to be developed in order to provide guidance to those responsible for planning and reviewing wastewater projects. The criteria must remain flexible to accept the widely varying functions and values of individual wetlands on a national, state, and substrate (regional) level. They must also be succinct enough to direct planning efforts in a timely manner with sufficient requirements to afford reasonable resource protection. (See also W89-01827) (Lantz-PTT)
W89-01852

MANAGEMENT POTENTIAL FOR NUTRIENT REMOVAL IN FORESTED WETLANDS,

East Carolina Univ., Greenville, NC. Dept. of Biology.

M. M. Brinson.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 405-416, 7 fig, 22 ref.

Descriptors: *Wetlands, *Wastewater treatment, *Forests, *Nutrients, *Wetland treatment, Biodegradation, Wastewater management, Biological treatment, Wastewater disposal.

Workshops, reviews, and symposia during the past decade and several ecosystem-level studies on wetlands have provided enough information to allow the evaluation of the capacity of some of these ecosystems to retain and process nutrients. For example, the great majority of wetlands occur in depositional environments that tend to accumulate materials (sediments) from adjacent ecosystems. Although geologic events or human alterations may quickly reverse this trend of accretion, wetlands are depositional environments in contrast to uplands. A wastewater treatment function is an attempt to capitalize on the capacity for material accumulation beyond natural levels. Another attribute of wetlands is that they tend to be more complex structurally than streams, the latter serving as the traditional discharge point for sewage effluent. Discharge lines often bypass wetlands that could provide a filtering function if an effective distribution system were designed. How variations among wetland types may affect their suitability for wastewater treatment is briefly examined. Finally, an experimental approach for assessing sustained nutrient loading is evaluated. (See also W89-01827) (Lantz-PTT)
W89-01853

WETLAND-WASTEWATER ECONOMICS,
Williams and Works, Grand Rapids, MI.
J. C. Sutherland.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 417-426, 3 fig, 2 tab, 4 ref.

Descriptors: *Economic aspects, *Wetlands, *Wastewater treatment, *Wetland treatment, Houghton Lake, Michigan, Costs, Maintenance, Electricity, Monitoring, Construction costs, Phosphorus removal, Secondary wastewater treatment, Wildlife.

In the mid-1970s, there was a great need in Michigan for economical, postsecondary wastewater treatment, including phosphorus (P) removal. Wetland application for removal of P from this community's stabilization pond effluent seemed an affordable alternative. By early 1976, four years of research at the Porter Ranch peatland near Houghton Lake, Michigan indicated excellent renovation of wastewater and nitrogen (N) species by wetland application. EPA funded the design and construction of a wetland treatment project through the Municipal Construction Grants program, and state and federal review agencies had understandable concerns for the integrity of this pristine natural wetland. The factors that brought success to the project were excellent P-removal potential, prospects for net positive environmental responses, an informed local populace, and great projected savings in wastewater treatment costs. The construction cost for the wetland at Houghton Lake was projected in 1976 to be $600,000. The construction of the upland irrigation alternative was projected at $1.1 million, or 83% higher. The construction of the wetland wastewater facilities, in fact, cost approximately $400,000 (1978 dollars). Labor at Houghton Lake, including overhead and administration, is $4,320. Electrical energy costs last year were $2,200. The most significant factor in the Houghton Lake electrical budget is friction losses in the forceline. Equipment, repair, and replacement are relatively minor, costing $1500 last year. Environmental monitoring costs were $10,000 last year, $5,000 for wildlife studies and $5,000 for vegetation-related studies. Costs of operation are also discussed for a wetland system in Vermontville, Michigan. (See also W89-01827) (Lantz-PTT)
W89-01854

USE OF WETLANDS FOR WASTEWATER TREATMENT AND EFFLUENT DISPOSAL: INSTITUTIONAL CONSTRAINTS,
Environmental Protection Agency, Washington, DC.
F. Rusincovitch.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 427-432.

Descriptors: *Wetlands, *Wastewater treatment, *Institutional constraints, *Legal aspects, *Wetlands treatment, *Regulations, Wastewater disposal, Municipal wastewater, Biological treatment, Biodegradation.

The Environmental Protection Agency's (EPA) Office of Federal Activities (Policy and Procedures Branch and 404 Branch) and the Office of Water Programs, in conjunction with the U.S. Fish and Wildlife Service, are considering the use of wetlands to treat municipal wastewater. The impetus for such use is that many small communities have found that 'high-technology,' conventional municipal sewage treatment systems are not well suited to their limited needs. While there does not appear to be any unequivocal constraint in any existing laws, regulations, or guidelines that would prevent the sensible use of wetlands in a municipal wastewater treatment system, the idea is new, and it requires a reassessment of whether or not wetlands serve their greatest value when left completely alone. Wetlands used for wastewater treatment promote their multiple use, hopefully, to the benefit of both the residents of the community and the wetland. However, there are those who believe that people and their wastes do not belong in wetlands because the wetland should be left completely natural; or that the only 'real' way to treat sewage is in concrete tanks with mechanical mixers and pumps where the chemistry and biology of waste treatment can be carefully controlled and monitored to prove the best-possible level of treatment. Proponents of these arguments have the potential to exert strong pressures on communities to pursue the more-established, conventional wastewater treatment routes, simply because they will seem easier or safer in the absence of complete knowledge about all wetland impacts. No doubt, over time, the use of wetlands in the treatment and disposal of municipal wastewater by small communities with appropriate land resources and soils will become an established procedure. However, the amount of time that the establishment of wetlands treatment takes will depend to a great on how quickly EPA can satisfy a community's concerns for what they perceive as the institutional, engineering, and biological constraints to wetland use for municipal waste treatment. (See also W89-01827) (Lantz-PTT)
W89-01855

RESPONSES OF WETLANDS AND NEIGHBORING ECOSYSTEMS TO WASTEWATER,
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
For primary bibliographic entry see Field 5C.
W89-01856

WETLANDS, WASTEWATER, AND WILDLIFE,
Utah State Univ., Logan. Dept. of Wildlife Science.
For primary bibliographic entry see Field 5C.
W89-01857

WETLANDS FOR WASTEWATER TREATMENT: AN ENGINEERING PERSPECTIVE,
Cold Regions Research and Engineering Lab., Hanover, NH.
S. C. Reed, and R. K. Bastian.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 444-450, 3 ref.

Descriptors: *Wetlands, *Wastewater treatment, *Wetlands treatment, Wastewater management, Municipal wastewater, Regulations, Ecological effects, Biological oxygen demand, Suspended solids, Heavy metals, Wastewater disposal, Artificial wetlands.

Under the right conditions, wetland systems can achieve high removal efficiencies for biochemical oxygen demand (BOD), suspended solids (SS), trace organics, and heavy metals. They have considerable potential as a low-cost, low-energy technique for upgrading wastewater effluent. Ecological considerations are a major concern where natural wetlands are involved in wastewater treatment or disposal of treated effluents, or where wastewater is involved in the enhancement or restoration of wetlands. Ecological aspects are less critical for constructed, or artificial, wetland systems than for natural wetland treatment systems. From a regulation standpoint, the use or discharge of treated effluents and providing wastewater treatment are not always the same thing. Natural wetlands are usually considered as a part of the adjacent water body and, therefore, under the Clean Water Act, discharges of municipal effluents to a natural wetland must be treated to at least the level of secondary treatment. This restriction limits the potential use of natural wetlands for municipal wastewater treatment. Rather than a single concept for the involvement of wetlands in wastewater treatment, there appear to be a continuum of possibilities for the tolerable (if not beneficial), as well as functional, combining of wastewater and wetlands. Four major categories of wetland-wastewater combinations have been observed that have been successful on the basis of ecological, engineering, economic, political, and social criteria: Category A, use of natural wetlands for the disposal of treated effluent; Category B, use of wastewater for wetland enhancement, restoration, or creation; Category C, use of natural wetlands for wastewater renovation; and Category D, use of a constructed wetland for relatively high rate wastewater treatment. Although the emphasis shifts from optimization of a wetland's overall values to optimization of the costs of wastewater treatment, all four categories either directly or indirectly do provide for some treatment of the wastewater. (See also W89-01827) (Lantz-PTT)
W89-01858

STRATEGY FOR WHOLE EFFLUENT TOXICITY EVALUATIONS IN NORTH CAROLINA,
North Carolina Dept. of Natural Resources and Community Development, Raleigh. Div. of Environmental Management.
For primary bibliographic entry see Field 5C.
W89-01904

PROCEEDINGS OF THE 42ND INDUSTRIAL WASTE CONFERENCE.
Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. 1000p.

Descriptors: *Waste treatment, *Wastewater treatment, *Conferences, *Waste disposal, Pretreatment of water, Aerobic digestion, Anaerobic digestion, Bioassays, Hazardous wastes, Landfills, Industrial wastes, Chemical treatment, Mine drainage, Leachates.

Ninety-six technical papers presented during the three days of the conference are presented, organized in the following sections: Pretreatment Programs, Landfill Site Remediation, Chemical Stabilization, Aerobic Fixed-Film Processes, Sorption Processes, Pulp and Paper Mill Wastes, Oil and Grease Wastes, Groundwater Treatment Methods, Application of Bioassays, Bacterial Supplementation, Wastewater Minimization and Reuse, Hazardous and Toxic Wastes, Process and Product Development, Meatpacking Wastes, Chemical Treatment Methods, Aerobic Processes, Anaerobic Processes, Land Disposal, Resin Technology, Heavy Metal Wastes, and Landfill Leachate and Mine Drainage. A comprehensive 10-year index to this and previous volumes is included. The index is cross-referenced by author and subject. (See W89-02007 thru W89-02096)
W89-02006

SEATTLE METRO'S INDUSTRIAL PRETREATMENT PROGRAM: A CASE STUDY

FOR REGULATION OF THE BOEING COMMERCIAL AIRPLANE COMPANY,
Seattle Metro Water Quality Lab., WA.
V. M. Ciccolo.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 1-6, 2 fig, 1 tab, 3 ref.

Descriptors: *Seattle, *Case studies, *Industrial wastewater, *Pretreatment of wastewater, Wastewater treatment, Metal-finishing wastes, Recycling, Waste recovery.

The Municipality of Metropolitan Seattle's Water Pollution Control Department provides sewage collection and treatment services for 1 million people in the Puget Sound region. Metro maintains 5 wastewater treatment plants ranging in size from 5 to 150 million gallons per day (gpd) which provide primary and secondary treatment for effluent discharges to Puget Sound. Four of the Boeing Company's plants are located in Metro's service area. Boeing is Metro's largest industrial user, collectively discharging 1.3 million gpd of metal finishing wastewaters from the Plant II, Kent Aerospace, Renton, and North Boeing Field plants. The Boeing Renton plant covers 300 acres. A wide variety of standard, as well as proprietary aircraft metal finishing operations take place at this facility. The Boeing Renton plant is currently permitted for 175,000 gpd of industrial effluent. Pretreatment strategies at the Renton plant focus on small, localized batch treatment plants, recycle-reuse, and process changes. Boeing has currently built two batch treatment plants (10,000 to 30,000 gallons) to remove heavy metals using standard hydroxide and sulfide precipitation chemistries and to strip volatile solvents from painting wastes. Several other similar localized treatment plants are in the planning phases. The costs of water and sewer service as well as those of chemical purchases and disposal methods have created healthy incentives for recycling, reuse, and waste minimization technologies. Boeing has made significant reductions in the amounts of chrome and wastewater volume over the past six years. For example, in 1980 the Renton facility was permitted to discharge 10 lbs of chrome and 625,000 gallons of industrial effluent per day. (See also W89-02006) (Lantz-PTT)
W89-02007

IMPLEMENTATION AND ENFORCEMENT OF AN INDUSTRIAL WASTE PRETREATMENT PROGRAM IN ORLANDO, FLORIDA,
Orlando, FL.
E. T. Skene, and E. L. Melear.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 7-13, 1 fig, 6 tab.

Descriptors: *Wastewater treatment, *Industrial wastes, *Orlando, *Florida, *Pretreatment of wastewater, Case studies, Metal-finishing wastes, Biological treatment, Regulations.

An industrial waste pretreatment (IWP) program was developed for the City of Orlando, Florida through the combined efforts of the City and a private contractor. After the Florida Department of Environmental Regulation (FDER) mandated the cessation of effluent discharges into surface waters, the City chose to reuse the highly treated effluent for: (1) irrigating 10,000 acres of citrus; (2) recharging the surficial aquifers; and (3) mitigating losses of wetlands. Stringent standards have been established for these methods of effluent reuse. Two case histories are presented to demonstrate the extreme of enforcement action. Industry A is an electroplating job shop with approximately 30 employees and a current water usage of approximately 7,000 gpd. It discharges into the Iron Bridge wastewater treatment works (WWTP), which is a 24 mgd rotating biological contactor (RBC) with effluent discharge into the Little Econlockhatchee River. The effluent limitations are BOD5-5 mg/L, TSS-5 mg/L, TN-3 mg/L, and TP-1 mg/L (advanced wastewater treatment). Enforcement of industrial pretreatment regulations began with code violation letters to Industry A) and eventually developed into severance of their industrial discharge service. The industry is currently working on a recycling and reuse program to minimize the discharge into the city sewer system. An agreement has been made to allow a limited industrial discharge under strict controls. Industry B is a printed circuit board manufacturer with approximately 350 employees and a water usage of 275,000 gpd. They use precipitation and filters for their main pretreatment, but sodium borohydride is an effective backup precipitating agent. The Conserv II WWTP, which receives their flow, is a 12 mgd activated sludge plant which discharges effluent either onto 10,000 acres of citrus groves or into rapid infiltration basins. Two constituents discharged by Industry B, boron and copper, are extremely toxic to the citrus trees and are of special concern. Because the plant only needed to meet secondary treatment standards and because of the activated sludge process, historical plant upsets were not as severe as with the Iron Bridge WWTP and therefore no recorded. (See also W89-02006) (Lantz-PTT)
W89-02008

COOPERATIVE EFFORT TO REMEDIATE A HISTORICAL PCB DISPOSAL SITE,
Aluminum Co. of America, Davenport, IA. Davenport Works.
For primary bibliographic entry see Field 5G.
W89-02010

DESIGN, ECONOMICS, AND OPERATION OF A BIOLOGICAL TREATMENT SYSTEM FOR KETONE CONTAMINATED GROUND AND SOLVENT RECOVERY PROCESS WATERS,
DETOX, Inc., Dayton, OH.
G. J. Skladany, J. M. Thomas, G. Fisher, and R. Ramachandran.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 53-58, 5 fig.

Descriptors: *Wastewater treatment, *Ketones, *Biological treatment, *Groundwater pollution, *Water pollution treatment, *Cleanup operations, Solvents, Economic aspects, Organic compounds, Water pollution prevention, Hazardous wastes.

Groundwater at the MEMOREX Computer Tape Plant (Santa Clara, CA) contaminated with several organic solvents (primarily methyl-ethyl ketone) was successfully treated using DETOX submerged fixed-film biological reactors. As the contamination level in the groundwater decreased, the plant piping and biotreatment system was reconfigured to allow it to receive both solvent recovery and miscellaneous solvent wastes produced at the facility. Combined waste stream organics in fluctuating concentrations as high as 700 mg/L could be consistently treated to < 5 mg/L. The biological treatment system has successfully remediated approximately 3.1 million gallons of water over a 43 week period. On-site treatment of hazardous wastes has significantly reduced potential future environmental liabilities while allowing the company to save $115,000/yr in off-site disposal costs. (See also W89-02006) (Lantz-PTT)
W89-02012

STABILIZATION OF A THERMALLY SENSITIVE NITRO-COMPOUND WASTE,
Air Products and Chemicals, Inc., Allentown, PA. Chemicals Div.
For primary bibliographic entry see Field 5E.
W89-02014

UTILIZING HIGH RATE FIXED-FILM BIOLOGICAL TECHNOLOGY TO CONTROL UPSET CONDITIONS IN REFINERY WASTEWATER TREATMENT SYSTEMS,
Witco Corp., Bradford, PA.
A. J. Bartoldi, G. E. Hillard, and J. E. Blair.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 85-92, 11 fig, 5 tab, 10 ref.

Descriptors: *Oil wastes, *Refinery wastes, *Wastewater treatment, *Fixed-film reactors, *Biological wastewater treatment, *Industrial wastewater, Biological oxygen demand, Chemical oxygen demand, Bacteria, Costs, Performance evaluation.

The Kendall Refining Company has been treating wastewater since the early seventies. The treatment was limited to chlorination to oxidize the phenols and a make-shift cooling tower to control thermal pollution. The plant has had difficulties consistently meeting effluent requirements for biological oxygen demand (BOD) and chemical oxygen demand (COD). Investigations of the contributions of various plant streams were conducted. Components exhibiting high tendencies toward BOD and COD were analyzed. Through these investigations, three sources were discovered. These were: crude desalter water, water from an electrostatic process removing inorganic chlorides from crude oil; methyl ethyl ketone (MEK), a solvent from lube oil dewaxing; and n-methyl12-pyrrolidone (nMP), a solvent from a lube oil extraction process. The current treatment scheme includes: a gravity oil/water separator for gross oil removal, an induced air floatation unit (IAF) plus the addition of a poly-electrolyte for the removal of oils and suspended solids, chlorine dioxide addition for the destruction of phenols and to act as a biocide for the cooling tower before discharging into the creek. Caustic soda and sulfuric acid are utilized for pH control. An engineering firm was contracted to investigate the feasibility of activated carbon treatment for BOD removal. After some preliminary investigations, they concluded that biological treatment is the only wastewater treatment scheme which can be expected to meet effluent criteria. From the results obtained in the pilot unit testing, it can be concluded that the fixed film technology is shown to be promising. This treatment scheme meets the desired specifications: effluent quality meets NPDES limitations; system tolerant to anomalies with bacterial versatility for quick recovery time and stability; low real estate requirements; and cost effectiveness. (See also W89-02006) (Lantz-PTT)
W89-02015

EVALUATION OF CARBON IMPREGNATED POLYURETHANE FOAM MEDIA FOR BIOLOGICAL REMOVAL OF CARBON AND NITROGEN FROM CHEMICAL INDUSTRY WASTEWATER,
CH2M Hill, Inc., Atlanta, GA.
S. W. Givens, and W. A. Sack.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 93-102, 3 fig, 7 tab, 21 ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Polyurethane foam, *Biological treatment, *Activated carbon, *Nitrogen, Suspended solids, Nitrification, Denitrification, Performance evaluation, Nitrogen removal, Biomass.

Porous biomass support systems (PBSS) have been in the developmental stages for a number of years and are considered one of the emerging innovative and alternative (I/A) wastewater treatment technologies by the U.S. EPA. A laboratory study was undertaken to evaluate the performance of a PBSS using a carbon-impregnated polyurethane foam pad for removal of purity pollutants and nitrogen. The biomass concentrations within the reactor were easily increased by using porous biomass supports. Biomass levels in the pad reactor averaged 8,490 mg/L and only 5,080 mg/L in the control. Pad activated carbon loss in the reactor was only 3 to 4% of the total pad activated carbon. Better suspended solids control was observed in the pad reactor throughout this study. Use of the pads promotes a high attached growth fraction, allowing a higher effective reactor mixed liquor suspended solids without loss of solids in the effluent. Substantial nitrogen removal was obtained in the pad reactor, primarily through simultaneous nitrification/denitrification at relatively high dissolved oxygen concentrations. Substantial oxygen and alkalinity savings were obtained in the pad reactor with the incorporation of denitrification. Diffusional limitations may be exploited to some

extent in order to create anoxic biomass fractions within single-stage aerobic reactors. Fluidized bed reactors appear to be best suited for this purpose. (See also W89-02006) (Lantz-PTT)
W89-02016

BIOFILM CHARACTERISTICS IN A FLUIDIZED-BED BIOREACTOR,
Massey Univ., Palmerston North (New Zealand). Dept. of Biotechnology.
S. M. R. Bhamidimarri, P. F. Greenfield, and P. R. F. Bell.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 103-111, 6 fig, 5 tab, 33 ref.

Descriptors: *Biofilms, *Fluidized bed reactors, *Bioreactors, *Wastewater treatment, Biomass, Biological treatment, Tracers, Membranes.

Fluidized-bed biofilm reactors have been increasingly considered for microbial applications, especially in biological wastewater treatment, in view of their superiority over other conventional systems. Removal of organic carbon and nitrogen have been accomplished employing fluidized-bed reactors, which provide much higher productivities than conventional suspended growth activated sludge or attached growth biological trickling filters. This comes about because of the large surface area available for growth resulting in high biomass concentrations. Effective substrate diffusivities into the biofilm and biofilm dry density, the most important of the biofilm characteristics, which determine the performance of the process, need to be determined accurately for an accurate quantitative analysis of the process. The technique described in this work for the estimation of effective substrate diffusivities makes use of standard equipment and a tracer, which can be measured very accurately. It is expected that the value of porosity to tortuosity ratio is applicable to any bacterial film comprising spherical and rod shaped cells. However, caution should be exercised in extrapolating these values to mycelial pellets or to filamentous growths. The biofilm dry density varies linearly with biofilm thickness between 0.01 cm and 0.025 cm. However, the variation is small enough to permit the use of an average value of 0.033 g/cu cm. (See also W89-02006) (Lantz-PTT)
W89-02017

USE OF TAILORED CLAYS FOR SELECTIVE ADSORPTION OF HAZARDOUS POLLUTANTS,
New Mexico State Univ., Las Cruces. Dept. of Civil Engineering.
F. Cadena, and S. W. Jeffers.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 113-110, 9 fig, 10 ref.

Descriptors: *Wastewater treatment, *Adsorption, *Clay, *Hazardous wastes, Bentonite, Benzene, Organic compounds, Chloroform, Activated carbon, Hydrogen ion concentration.

Use of tailored clays for selective removal of hazardous pollutants is a promising treatment alternative. In particular tetramethylammonium (TMA)-bentonite may be used to selectively remove benzene from solutions containing closely related contaminants. The absorptive capacity of bentonite is greatly increased when TMA is used as a tailoring agent. Specifically, TMA bentonite is highly effective for the removal of benzene from aqueous solutions. However, the capacity of TMA-bentonite to adsorb benzene is somewhat lower than the capacity of granular activated carbon in the range of concentrations studied. TMA bentonite is highly selective for benzene, while adsorption of methylbenzenes and chloroform is several orders of magnitude lower than those for benzene. TMA bentonite removes benzene from solution at a faster rate than granular activated carbon. Adsorption of the organic compounds tested onto TMA-bentonite is partially improved by decreasing the pH of the solution. However, adsorption capacity variations over the pH range found in natural waters are expected to be insignificant. Removal of TMA bentonite from suspension is easily accomplished by gravitational settling due to the coagulating nature of the TMA ion. (See also W89-02006) (Lantz-PTT)
W89-02018

TREATMENT OF CR(VI) CONTAINING WASTEWATER BY ADDITION OF POWDERED ACTIVATED CARBON TO THE ACTIVATED SLUDGE PROCESS,
Thew Korea Inst. of Construction Technology, Inchon. Dept. of Environmental Engineering.
S. E. Lee, H. S. Shin, and B. C. Paik.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 121-130, 9 fig, 5 tab, 16 ref.

Descriptors: *Chromium, *Wastewater treatment, *Activated carbon, *Activated sludge, Flocculation, Adsorption, Sludge, Chemical oxygen demand, Biological oxygen demand.

Adsorption of Cr(VI) on activated sludge floc was not significant although the initial adsorption rate on activated sludge floc was relatively fast. Adsorptive capacity of powdered activated carbon (PAC) for Cr(VI) was much higher than that of activated sludge floc and the initial adsorption rate was very fast, i.e., 66% of the equilibrium value was reached in 30 minutes. The adsorption of Cr(VI) on PAC and activated sludge floc could be well described by a Freundlich isotherm. The oxygen uptake rate of activated sludge stressed by CR(VI) could be recovered by the addition of PAC. Time required for recovery from the upset by an increase in Cr(VI) concentration was 1 day for the PAC unit while it was longer than 7 days for the unit without PAC. Higher removal efficiencies of COD and CR(VI) were obtained from the PAC unit than the unit without PAC addition. Both units showed high COD removal efficiencies. However, the removal of Cr(VI) by the unit without PAC was only 9%, while it was 41% for the PAC unit. The PAC unit showed higher biological activities, as assessed by oxygen uptake rate, yield coefficient and first order substrate removal rate constant, than the unit without PAC. (See also W89-02006) (Lantz-PTT)
W89-02019

SEASONAL ASPECTS OF ORGANIC HALIDE REMOVAL BY AN AERATED LAGOON TREATING A PULP AND PAPER WASTEWATER,
Arizona Univ., Tucson. Dept. of Civil Engineering.
C. W. Bryant, G. L. Amy, and B. C. Alleman.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 131-136, 6 fig, 2 tab, 22 ref.

Descriptors: *Seasonal variation, *Halides, *Pulp and paper industry, *Wastewater treatment, *Aerated lagoons, Oxygen, Kraft mills, Temperature, Biological treatment, Adsorption, Anaerobic digestion, Dehalogenation, Industrial wastes.

An aerated lagoon operated for removal of soluble oxygen demand removed approximately one-third to one-half of total organic halide (TOX) in Kraft mill wastewater. Over 3 wk in summer 1986, total TOX removal was 37% and removal of <1000 average molecular weight (AMW) was 30%. For the same period total organic carbon (TOC) removal was 27% and removal of <1000 AMW TOC was 50%. In 1987 (2 wk in spring), total TOX removal was 44% and removal of <1000 AMW was 57%. For the same period in 1987 total TOC removal was 45% and <1000 AMW TOC removal was 74%. Moderate temperature reduction resulted in greater removal of TOX and low-molecular-weight TOX. Such effects were consistent with removal by biosorption. Process and operational strategies, predicated on the key roles of biosorption and anaerobic dehalogenation, may provide improved TOX removal. (See also W89-02006) (Lantz-PTT)
W89-02020

IMPROVING STABILITY OF A PAPER MILL SLUDGE,
Wisconsin Dept. of Natural Resources, Madison.
A. Bagchi.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 137-141, 2 fig, 2 tab, 2 ref.

Descriptors: *Wastewater treatment, *Waste disposal, *Sludge, *Pulp and paper industry, *Stabilization, Fly ash, Landfills, Pore pressure, Shear strength, Industrial wastes.

The benefit of mixing fly ash with paper mill sludge for increasing stability is discussed. Addition of fly ash, sufficient volume of which is produced in most paper mills, will definitely increase its stability. However, before increasing the top slope of 'mixed sludge', proper investigation must be undertaken. Such investigations should include both theoretical stability analysis and actual observation in the field. Long-term shear strength parameters obtained from laboratory tests may not be accurate because generation of gas during testing may influence their values. Therefore, lower (75% of laboratory values) values of shear strength parameters should be considered for the stability analysis. In this particular study top slope stability of an old land fill was helpful in making a decision. If 'stable slope data' from an 'old sludge landfill' is not available, the author recommends a longer field stability study using the mixed sludge. Pore pressure dissipation will depend on the permeability of the sludge, thickness of each lift of sludge, and rate of filling. Therefore, these items should be considered in deciding how long the field stability study should continue. (See also W89-02006) (Lantz-PTT)
W89-02021

REMOVAL OF OIL AND GREASE IN THE HYDROCARBON PROCESSING INDUSTRY,
Los Angeles County Sanitation Districts, Whittier, CA.
C. H. Rhee, P. C. Martyn, and J. G. Kremer.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 143-150, 9 fig, 26 ref.

Descriptors: *Wastewater treatment, *Hydrocarbons, *Industrial wastewater, *Oil recovery, *Grease, *Separation techniques, Oil, Petroleum products, Ultrafiltration, Filtration, Biological treatment.

The hydrocarbon processing industry in the Sanitation Districts of Los Angeles County's (Districts) service area includes petroleum refining, petrochemical processing, crude oil and natural gas production, and related chemical companies. The volume of wastewater discharged from the hydrocarbon processing industry is approximately 23 mgd which is about 35% of the Districts' total industrial wastewater flow and 6% of the 365 mgd of wastewater influent to the Districts' Joint Water Pollution Control Plant (JWPCP). Crude oil capacities of petroleum refineries total nearly one million barrels per day. The most important pollutants in the hydrocarbon processing industry are conventional pollutants such as oil and grease, suspended solids and pH, and nonconventional pollutants such as phenolic compounds; COD, sulfide and ammonia. Among these pollutants, oil and grease is one of the most complicated pollutants to remove. This paper summarizes available technologies to remove oil and grease and should assist oil and grease dischargers in complying with their effluent limits, including: (1) oil-water separators; (2) dissolved air flotation oil-water separation; (3) induced air flotation oil-water separation; (4) ultrafiltration; and (5) biological treatment. (See also W89-02006) (Lantz-PTT)
W89-02022

ANOMALIES IN OIL AND GREASE ANALYSES OF PETROLEUM WASTEWATERS AND THEIR IMPLICATIONS,
Shell Oil Co., Houston, TX.

For primary bibliographic entry see Field 5A.
W89-02023

BIOTREATMENT INHIBITION BY HAZARDOUS COMPOUNDS IN AN INTEGRATED OIL REFINERY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
M. Rebhun, and N. Galil.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 163-174, 11 fig, 4 tab, 16 ref.

Descriptors: *Wastewater analysis, *Water analysis, *Biological treatment, *Hazardous wastes, *Oil refineries, Industrial wastewater, Organic compounds, Separation techniques, Flocculation, Biological oxygen demand, Suspended solids, Volatile organic compounds, Phenols, Activated carbon, Activated sludge process.

Biological treatment of wastewater from an integrated oil refinery, containing hazardous contaminants, was studied in an on-site pilot plant. The wastewater is pretreated by gravity separation, flocculation, and dissolved air flotation. Biotreatment of such wastewaters is feasible, but it poses several problems which have to be considered in planning, design, and operation of the treatment system. The process rate is relatively slow, the specific loading rate should be below 0.15/day in terms of biological oxygen demand (BOD), for efficient treatment. This is due to inhibitory effects of phenols. The mixed liquor volatile suspended solids is due to poor settleability of part of the biofloc and its 'escape' from the secondary clarifier affecting adversely also the quality of the effluent. Sudden discharges of concentrated phenolic wastes disrupted the process, first by impairing bioflocculation and then by complete inhibition of the biological process. To prevent such disturbances, surges of concentrated wastes containing toxic and inhibitory compound should be intercepted and stored. Further improvement in performance of biological treatment is now being studied using powdered activated carbon (PAC) in the activated sludge process. The results up to now indicate that it improves the process, probably by reducing the inhibitory action of the phenols at the steady state influent concentrations. Powdered activated carbon combined in the activated sludge cannot be a solution for the sudden high volume discharges of concentrated phenols. This problem can be solved only through interception, storage and regulated gradual discharge. (See also W89-02006) (Lantz-PTT)
W89-02024

BIODEGRADATION OF OILFIELD PRODUCTION PIT SLUDGES,
Louisiana State Univ., Baton Rouge. Dept. of Petroleum Engineering.
R. E. Marks, S. D. Field, and A. Wojtanowicz.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 175-183, 6 fig, 7 tab, 17 ref.

Descriptors: *Biodegradation, *Wastewater treatment, *Sludges, *Oil wastes, Biological treatment, Industrial wastes, Oil refineries, Suspended solids, Volatile organic compounds, Biomass, Oxygen.

The major components of oilfield production waste pits are: formation waters, crude oil, produced sands, and spent chemicals used for surface treatment of produced oil. High molecular weight hydrocarbons often accrue from separations in the oilfield production tanks. A laboratory study is described in which the potential for biological treatment of oil-based drill cuttings and a production sludge from an oilfield waste pit was evaluated. The drill cuttings were acquired from drilling operations off the Louisiana coastline as a composited waste while the production sludge was samples from a 32-year old continuously operating oilfield sludge pit. Biodegradation is illustrated through three transfers of the Oil Refinery Waste (ORW) microbial population (ORW T5 to ORW TV2) and represents a good example of acclimation of this culture to the complex hydrocarbon fractions in the drill cuttings. Each sample contained 2.4% oil and grease (O and G) v/v and 2.0% solids w/w. These results are typical of efforts of other investigators to accelerate startup times associated with biological processes. The 40 hour reaction velocity for ORW TV2 and TV1 averaged 22 mg/L/hr or double the sludge rate. An increase in solids loadings to 5.4% w/w, for a 3% O and G v/v drill cuttings sample, resulted in a reaction velocity of 40 mg/L/hr and approached the limiting oxygen generation rate of the respirometer equipment. The peak biomass growth was estimated at 5000 mg/L mixed liquor volatile suspended solids. The dilute concentrations of drill cuttings (1-4% O and G v/v), all formed swollen gels which decomposed after 18-24 hours of degradation. The residual solids after a 4% O and G v/v biodegradation, dried to an inert powder which would not require further treatment and be readily disposable. The biological treatment process would seem to be an excellent alternative to conventional technologies for this difficult way to treat waste. (See also W89-02006) (Lantz-PTT)
W89-02025

DEVELOPMENT OF LOW-COST FLOTATION TECHNOLOGY AND SYSTEMS FOR WASTEWATER TREATMENT,
Krofta Engineering Corp., Lenox, MA.
M. Krofta, D. Guss, and L. K. Wang.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 185-195, 6 fig, 2 tab, 24 ref.

Descriptors: *Flotation, *Wastewater treatment, *Biological wastewater treatment, Activated sludge process, Bulking sludge, Rising sludge, Flocculation, Biological oxygen demand, Suspended solids, Biomass, Chlorination, Oxidation, Sedimentation.

The use of secondary flotation clarification in place of, or in assisting secondary sedimentation clarification in the activated sludge process system is one recent advancement in biological wastewater treatment. The primary distinguishing feature of the improved activated sludge treatment system is that high rate dissolved air flotation, known as Supracell, is the secondary clarifier for separation of suspended solids from the aeration basin effluent, as opposed to secondary sedimentation alone in conventional activated sludge systems. The most common operational difficulties encountered in the conventional activated sludge treatment plant are rising sludge and bulking sludge, resulting in high suspended solids and 5-day BOD in the plant effluent. The common cause of rising sludge is biological denitrification, in which nitrites and nitrates in the wastewater are converted to nitrogen gas. When enough nitrogen gas is formed, and trapped in the sludge mass, the sludge in the conventional secondary sedimentation clarifier becomes buoyant and floats to the surface. This phenomenon is termed biological flotation. Rising sludge can also be caused by internal solids overloading and hydraulic overloading to the secondary sedimentation. Poor sedimentation clarifier design and operation in terms of flow-through velocity, weir design, etc. are also possible causes. There are two principle types of sludge bulking problems: (1) the growth of filamentous organisms; and (2) the formation of swelling biological flocs through the addition of bound water to the cells to extent that their density is reduced. The state-of-the-art method for controlling sludge bulking in an emergency situation is chemical oxidation by chlorine or hydrogen peroxide. Another alternative involves the addition of a secondary flotation unit which parallels the existing secondary sedimentation unit in a conventional existing activated sludge treatment plant. (See also W89-02006) (Lantz-PTT)
W89-02026

BIODEGRADATION OF ORGANIC COMPOUNDS IN ANOXIC GROUNDWATER SYSTEMS,
Black and Veatch, Philadelphia, PA.
For primary bibliographic entry see Field 5G.
W89-02027

INVESTIGATION OF INGROUND BIOLOGICAL TREATMENT FOR GROUNDWATERS CONTAMINATED WITH VOLATILE ORGANIC COMPOUNDS,
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-02028

ON-SITE TREATMENT SYSTEMS FOR AQUIFER RESTORATION BIOLOGICAL TREATMENT,
Geraghty and Miller, Inc., Oak Ridge, TN.
For primary bibliographic entry see Field 5G.
W89-02029

EFFLUENT TOXICITY MONITORING METHODOLOGY EVALUATED FOR FIVE INDUSTRIAL DISCHARGERS,
Engineering-Science, Fairfax, VA.
E. C. Sullivan, J. A. Botts, J. W. Braswell, D. F. Bishop, and G. H. Slattery.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 237-256, 15 fig, 14 tab, 14 ref. EPA Contract CR812790-01-1.

Descriptors: *Wastewater treatment, *Wastewater analysis, *Industrial wastewater, *Monitoring, *Toxicity, *Water pollution prevention, Bioassays, Biological studies, Chemical oxygen demand, Microtox, Microbiological studies, Ceriodaphnia dubia, Lethal limits, Activated sludge, Biomass.

On-going, preliminary, industrial toxicity screening tests being conducted for the City of Baltimore's Patapsco Wastewater Treatment Plant (PWWTP), are presented. The screening tests at the PWWTP were conducted in two phases: (1) initial evaluation by batch biological treatment of industrial wastewater dilutions for a period of 2 hours in a respirometer; and (2) detailed evaluation by batch testing of industrial dilutions with nutrient addition and with O2 uptake and COD removal monitored relative to a control synthetic wastewater. Both phases included testing for Microtox toxicity removal and the second phase also included Ceriodaphnia dubia time-lethality analysis. The results are preliminary, however, this testing procedure can be used to screen for industries which may require more in-depth study, and alert municipalities to potential problem sources. Microtox toxicity reduction was not consistent with bioassay toxicity reduction. Therefore, industrial toxicity screening tests will require further development to evaluate and explain the inconsistency. The C. dubia toxicity present in the PWWTP return activated sludge filtrate contributed to the Ceriodaphnia toxicity in all of the batch treatability tests on the industrial wastewater discharges. Batch treatability tests of synthetic wastewater resulted in biological activity rates similar to those of PWWTP primary effluent. The tests with synthetic wastewater were used as a reasonable reference from which relative inhibition would be determined. Batch testing of dilutions of industrial wastewater can be used to screen for inhibitory effects on WWTP biomass. (See also W89-02006) (Lantz-PTT)
W89-02030

TOXICITY EVALUATION OF PERSISTENT ORGANIC CONTAMINANTS,
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
J. R. Hartman, C. R. Lange, M. R. Matsumoto, and A. S. Weber.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 265-273, 13 fig, 6 tab, 3 ref.

Descriptors: *Persistence, *Organic compounds, *Toxicity, *Biodegradation, Microbiological studies, Orthochlorophenol, Bioassay, Wastewater treatment.

A large number of xenobiotic chemicals are resistant to biological degradation, or are degraded at very low rates. This resistance to biodegradation it termed persistence. Persistence of xenobiotics can be attributed to: (1) the inhibitory nature of the chemical substance to the microorganisms; and/or (2) the microorganisms' lack of necessary enzymatic pathways necessary for the breakdown of specific compound(s). As a preliminary screening test, the use of plating techniques can be used to screen a large number of compounds and bacterial cultures for persistence. Results obtained using the solid agar plating technique were in good agreement with all of the other tests employed. Orthochlorophenol (OCP) was found to be much more persistent than 2,4-D. In addition, the time for growth to develop on the plates using 2,4-D as the sole carbon and energy source paralleled the time for initiation of biodegradation of 2,4-D in the batch shaker flask tests. To narrow the cause of persistence, acute toxicity tests are well suited. On the basis of the bioassay results from this study, OCP would be expected to impose a higher degree of toxic inhibition than 2,4-D. To determine the rate and degree of biodegradation, a simulation test (e.g. batch shaker flask test) must be employed. Use of these three tests together can be used to assess whether a xenobiotic will be persistent in a bioreactor, to determine the cause of the persistence, and estimate the rate and degree of biodegradation that can be achieved. Metabolic activity tests, oxygen consumption and ATP levels, are useful as complimentary analyses for the plating and acute toxicity tests. The results from both the oxygen consumption and ATP level tests were consistent with the solid agar plating, acute toxicity, and batch shaker flask tests. (See also W89-02006) (Lantz-PTT)
W89-02032

CONSTRAINTS OF BIOAUGMENTATION IN ENHANCING BIOLOGICAL TREATMENT PROCESS PERFORMANCE,
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
C. R. Lange, J. R. Hartman, N. M. Chong, A. S. Weber, and M. R. Matsumoto.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 275-284, 6 fig, 9 tab, 11 ref.

Descriptors: *Wastewater treatment, *Bioaugmentation, *Biological wastewater treatment, *Biodegradation, Bacteria, Microbiological studies, Heavy metals, Phenol, Chlorinated compounds, Fats, Proteins, Hazardous wastes, Industrial wastes, Food wastes, Starch.

Bioaugmentation is the process of adding nonindigenous bacterial supplements to a bioreactor for the purpose of artificially increasing the bacterial diversity and/or activity of the reactor population. Bioaugmentation may increase the biological diversity and activity of the population by: (1) adding bacteria with enzymatic systems which allow degradation of previously non-biodegradable organics; or (2) adding bacteria which have higher metabolic rates. Many bacterial supplements are available commercially to augment existing populations of biological hazardous waste treatment processes. The supplements investigated here were: targeted for: heavy metals, phenol, chlorinated organics, fats and proteins, hazardous wastes, industrial wastes, food wastes, septage, general wastes, and cold weather. A number of factors thought to be important in determining the potential of bacterial supplementation were investigated using a specific waste from a hazardous waste treatment, storage, and disposal facility, and bacterial supplements recommended for the waste by the commercial distributors. Most supplements recommended for the study waste were not able to initiate degradation of the study waste without a period of acclimation. Parameters such as supplement viability, acclimation, and population retention are important. The study waste, which modeled an expected indigenous population, performed as well as any commercial supplement. The population acclimated to soluble starch, which had not been used with the study waste, performed as well as some of the recommended commercial supplements. It is not certain that bioaugmentation is feasible. (See also W89-02006) (Lantz-PTT)
W89-02033

BIOAUGMENTATION OF STRESSED ANAEROBIC FILTERS WITH METHANOGENIC ENRICHMENT CULTURES,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
N. Lynch, L. Daniels, and G. F. Parkin.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 285-296, 7 fig, 2 tab, 26 ref.

Descriptors: *Bioaugmentation, *Wastewater treatment, *Biological wastewater treatment, *Anaerobic digestion, *Filtration, Chemical oxygen demand, Biodegradation, Methane bacteria, Organic compounds, Methane, Bacteria, Microbiological studies.

Recently, advances in understanding the microbiology and biochemistry of the anaerobic breakdown of complex organic materials have suggested new methods for controlling system operation and improving recovery from shocks. An overall scheme of the bacterial degradation process consists of three main parts: (1) hydrolysis and fermentation of complex organic molecules into acetate, H2, and organic acids with more than 2 carbons; (2) conversion of long-chain acids into acetate, H2, and CO2; and (3) methane production from the cleavage of acetate and the reduction of CO2 with hydrogen. The concentration of hydrogen in an anaerobic system is considered by recent investigations to be the most important parameter in the efficient operation of the process. When the partial pressure of hydrogen is reduced to levels of 0.001 to 0.00001 atmospheres, these reactions can take place. Because of this, the syntrophs must exist in an obligate symbiotic relationship with an effective hydrogen consumer, and are difficult to maintain in a pure culture. For many years, the syntroph-methanogen consortium was considered to be a single bacterium, Methanobacillus omelianskii. Methanogens are capable of consuming hydrogen even when the amount available is exceedingly small. These bacteria are limited by a slow growth rate and a narrow range of pH tolerance, properties that can cripple the operation of an anaerobic reactor. The studies reported here describe the anaerobic degradation of whey in upflow submerged filters at mesophilic temperature. Anaerobic filters are capable of degrading a concentrated organic substrate at a high loading rate. During the 127 days of operation, the reactors were stable and adjusted quickly to increases in loading rate, removing 90% of TCOD and producing biogas with methane concentrations of 67-70%. The efficiency achieved with the high influent concentrations suggests that anaerobic fixed-film treatment of whey provides a means of waste disposal and energy production for dairies and cheese manufacturers. (See also W89-02006) (Lantz-PTT)
W89-02034

EFFICACY OF BIOAUGMENTATION PRODUCTS AS PREDICTED BY A MODEL OF STEADY-STATE FLOCCULENT CULTURES,
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
S. J. Hull, and R. B. Kapuscinski.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 297-308, 6 fig, 3 tab, 32 ref.

Descriptors: *Model studies, *Bioaugmentation, *Flocculation, *Hazardous wastes, *Wastewater treatment, *Biological wastewater treatment, *Microbiological studies, Organic compounds, Activated sludge, Biodegradation, Biomass.

A rational model of flocculent microbial cultures was developed to assess the efficacy of maintenance doses of bioaugmentation products upon the steady-state removal of a potentially hazardous organic compound (PHOC) that is resistant to microbial degradation. Steady-state simulations with this model indicate that the impact of bioaugmentation products is influenced by the product dose, the wastage ratio, and the influent concentration of the PHOC. However, for conditions representative of a completely-mixed activated sludge system, the model predicts that typically prescribed doses of bioaugmentation products will not have a substantial impact upon the removal of PHOCs that are resistant to microbial degradation. Moreover, the model predicts that lowering the biomass wastage ratio offers a potentially more effective means of improving the steady-state, microbial removal of resistant PHOCs in suspended-growth systems. (See also W89-02006) (Lantz-PTT)
W89-02035

DEVELOPMENT OF TREATMENT ALTERNATIVES THROUGH AN UNDERSTANDING OF WASTE CHEMISTRY,
RECRA Environmental, Inc., Amherst, NY.
T. F. Stanczyk.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 309-320, 8 fig, 5 tab, 5 ref.

Descriptors: *Hazardous wastes, *Toxic wastes, *Waste disposal, *Standards, *Waste treatment, *Chemical properties, Organic compounds, Inorganic compounds, Landfills, Volatile organic compounds, Toxicity, Solubility, Ignitability, Heavy metals.

Waste residues contain an array of inorganic and organic constituents varying in terms of mobility and hazard potential. The EPA proposed Toxic Characteristic Leaching Procedure Standards will undoubtedly focus on parameters and performance standards that are generally ignored in terms of waste treatment. Treatment alternatives are going to play an important role in waste minimization strategies. EPA performance standards for landfill candidates will force industry to assess waste properties and the degree of environmental concern. The overall approach to the development of a waste minimization strategy should allow for a waste-specific characterization program as well as source segregation and treatment alternatives that can prioritize as goals waste reclamation, detoxification, purification/reuse, volume reduction and safe disposal. Some of the existing limitations and waste restrictions of land disposal, focus on the following acceptance criteria: (1) Ignitability; (2) Volatile organic content; (3) toxicity; (4) solubility; and (5) physical properties. (See also W89-02006) (Lantz-PTT)
W89-02036

WATER REUSE AND RECYCLING IN INDUSTRY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
M. Rebhun.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 341-345, 5 fig, 1 tab.

Descriptors: *Wastewater treatment, *Water reuse, *Recycling, *Industrial wastewater, *Wastewater disposal, Case studies, Wastewater management, Economic aspects, Costs, Potential aspects, Social aspects, Regulations.

Wastewater reuse for and in industry and other purposes can and should be integral part of water resources management in water short areas. In the case studies described here, the cost of treatment and recycle could compete with real cost of fresh water, its treatment, plus the cost of waste treatment and disposal. The need of the reclaimed water and its value for the industry prompted installation of advanced treatment processes, thus providing better water pollution control. The reuse projects, though cost effective, needed the initiative and strong support of local and national government in their development stages. Also, many legal, political and institutional aspects have to be considered in all reuse-reclamation schemes, such as: water rights vs. effluent reuse, wastewater own-

erships and rights, and cost sharing in case of municipal effluent reuse. (See also W89-02006) (Lantz-PTT)
W89-02039

REGULATION OF TOXIC ORGANICS IN INDUSTRIAL SEWER DISCHARGES AT THE SANITATION DISTRICTS OF LOS ANGELES COUNTY,
Los Angeles County Sanitation Districts, Whittier, CA.
For primary bibliographic entry see Field 5E.
W89-02040

COMMUNITY INVOLVEMENT: THE CATALYTIC FACTOR IN WASTE MANAGEMENT,
Winsor Associates, Ardmore, PA.
For primary bibliographic entry see Field 6E.
W89-02041

INTEGRATED PLANT FOR TREATMENT OF DILUTE HAZARDOUS WASTE,
Aerojet Corp., Sacramento, CA.
P. Miedzinski, J. B. Glover, and M. S. Montgomery.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 379-391, 8 fig, 4 tab, 20 ref.

Descriptors: *Wastewater treatment facilities, *Hazardous wastes, *Wastewater treatment, Design standards, Construction, Industrial wastewater, Waste management, Costs, Economic aspects, Process water, Aerospace industry, California.

Aerojet, a division of Gencorp, is a Sacramento, California, based aerospace company primarily involved in the manufacture and development of liquid and solid rocket motor. Such manufacturing involves a number of processes which can generate dilute hazardous wastes which are hauled to Class 1 disposal sites. The Central Waste Management Department (CWM) is responsible for handling and disposing of all waste, both toxic and nontoxic, at the Sacramento facility. Within this department is the Central Waste Technology group that is responsible for developing and constructing facilities which can treat both toxic and nontoxic wastes. It is the goal of this group to minimize offsite disposal. Current, Aerojet generates approximately 2,000,000 gallons a year of aqueous dilute hazardous wastes. This paper discusses the pilot work and design considerations that culminated in the construction of a treatment plant for these wastes which will discharge effluent to a publicly owned treatment works (POTW). CWM initiated construction of the treatment plant in October 1986. Plant construction was completed (with the exception of installation of the gas chromatograph) in May 1987. Construction cost for the plant including engineering was $725,000. Operating costs are predicted to be between 10 and 15 cents per gallon depending upon carbon usage and solids cake disposal costs. At these costs, and with current waste generation rates, return on initial investment will be between 7 and 9 months. (See also W89-02006) (Lantz-PTT)
W89-02042

CHARACTERIZATION OF TREATMENT RESIDUES FROM HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES,
Metcalf and Eddy, Inc., Wakefield, MA.
B. D. Kaplan.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 409-417, 2 fig, 6 tab. EPA Contract No. 68-03-3166.

Descriptors: *Waste treatment, *Waste disposal, *Classification, *Hazardous wastes, Metal-finishing wastes, Industrial wastes, Organic compounds, Filtration, Incineration, Waste storage, Case studies.

EPA is required to evaluate alternative technologies for each waste category and to establish treatment standards for banned wastes based on the lowest level achieved by a best demonstrated available technology (BDAT). As part of the program to develop this information, field evaluation of alternative technologies for treating or destroying wastes that have been listed for priority action were conducted. The primary focus of this study was to evaluate the treatability of metal-bearing and solvent wastes. Facility A is a commercial offsite treatment facility accepting aqueous wastes generated by the electroplating industry, as well as other metal finishing operations. Facility B is a chemical manufacturing plant owned and operated by a major chemical company. Both solid and liquid hazardous organic wastes generated on-site and at several other company plants are incinerated at Facility B. Solid waste and sludges are received in drums and typically include paint sludges, chlorinated hydrocarbons, coke solids, vacuum filter solids, waste filter elements and polymeric tar. Liquid wastes, transported on-site by bulk tanker truck, commonly include waste organic solutions, waste solvents, tank farm nitrates and chloroprene catalyst sludge. The treatment train utilized at Facility A (cyanide oxidation, chromium reduction, chemical precipitation, vacuum filtration) successfully removed the metal compounds from the water environment. The metals were removed to below the pretreatment limits imposed by the local municipality. Moreover, the sludge sample extracts were within the threshold limits for metals and organics of the land disposal regulations. Evaluation of the data from Facility B indicates that significant levels of toxic metals are present in waste solvents and organic process wastes destined for incineration. Since metals are not destroyed by incineration, they tend to concentrate in the treatment residues ash and scrubber wastewater. Facility B, a properly designed and operated system, achieves complete destruction of organic compounds. (See also W89-02006) (Lantz-PTT)
W89-02045

SPENT CAUSTIC TREATMENT AND DISPOSAL,
Stone and Webster Engineering Corp., Boston, MA.
Y. S. Chen, and P. D. Burgess.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 429-436, 5 fig, 3 tab, 8 ref.

Descriptors: *Hazardous wastes, *Caustic soda, *Wastewater treatment, *Waste disposal, Chemical oxygen demand, Biological oxygen demand, Hydrogen ion concentration, Oxidation, Chemical precipitation, Stripping, Biological treatment, Chemical treatment, Sulfides.

Caustic soda is normally used in olefin plants to remove hydrogen sulfide and carbon dioxide from cracked gas streams. The resulting waste is known as spent caustic and is characterized by high concentrations of sulfide, dissolved solids, chemical oxygen demand (COD), and biochemical oxygen demand, and by high pH. Its high pH and sulfide content make spent caustic a hazardous waste under the Resource Conservation and Recovery Act (RCRA). Characteristics of spent caustic that make it difficult to treat have encouraged the use of deep well injection for disposal. Increasingly stringent RCRA regulations may preclude the use of deep well injection in the future. Alternatives to deep well injection include wet air oxidation, chemical oxidation, chemical precipitation, steam stripping, and, in certain cases, dilution with other wastes followed by oxidation in biological treatment systems. The characteristics, performance, and costs of these alternative technologies are described. (See also W89-02006) (Lantz-PTT)
W89-02047

IMPLEMENTATION OF AN AQUEOUS WASTE SUBSTITUTION PROJECT AT GIANT CEMENT COMPANY AND COMPLIANCE WITH THE ASSOCIATED PERMITS BY SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL,
South Carolina State Dept. of Health and Environmental Control, Columbia. Div. of Industrial and Agricultural Wastewater.
For primary bibliographic entry see Field 3C.
W89-02048

PRECAST CONCRETE DESIGN FOR TERTIARY WASTE TREATMENT PLANT SIGNIFICANTLY REDUCES TIME AND PROJECT COST,
Burlington Industries, Inc., Greensboro, NC. Architectural and Structural Section.
For primary bibliographic entry see Field 8F.
W89-02049

FIELD EVALUATION OF VACUUM ASSISTED SLUDGE DEWATERING BED SYSTEMS,
Montgomery (James M.), Inc., Pasadena, CA.
A. J. Condren, A. T. Wallace, I. A. Cooper, and J. F. Kreissl.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 451-455, 1 fig, 2 tab, 2 ref.

Descriptors: *Field tests, *Sludge drying, *Vacuum drying, *Wastewater treatment, Costs, Sludge, Solids, Sludge solids, Sludge cake.

Vacuum assisted sludge dewater bed (VASDB) systems are a proven, effective technology. In comparing VASDB systems against conventional sand drying beds, the assumptions regarding long-term loading rates will prove critical in the analysis, making local climatic conditions a very significant factor in the analysis. It must be recognized that the end product from the two concepts will not usually be the same. The sand bed will typically produce a sludge cake exceeding 30% solids while the vacuum bed is typically operated to produce a liftable (12 to 15% solids) cake. If treatment facility disposal practices require a higher solids concentration, an additional supplemental drying area may be needed for the vacuum assisted systems. On-going research and development is being directed at prolonging the service life of the media plats and reducing their cost. The major market to date has been at treatment systems with flows < 7500 cu m/d, however, the size of facilities which are giving serious consideration to this concept is gradually increasing. (See also W89-02006) (Lantz-PTT)
W89-02050

WASTE OIL RECOVERY,
Bird Machine Co., Inc., South Walpole, MA.
C. P. Steele, C. T. Mahoney, and J. D. West.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 457-463, 7 fig.

Descriptors: *Wastewater treatment, *Oil recovery, *Industrial wastewater, Heat treatment, Separation techniques, Chemical treatment, Costs analysis.

There are two key areas in a good waste oil recovery system. The first area is efficient heat-chemical treatment to reduce the emulsion (rag) phase of the waste oil stream as much as possible and, in turn, maximize the amount of free oil and free water in the stream. The more efficient the heat/chemical treatment the greater the amount of clean oil that can be recovered from the waste stream. The result is an increase in the efficiency of the overall recovery system. The second area is to incorporate separation equipment which has the versatility to compensate for changes in the waste oil stream while remaining on line. This versatility is directly related to both the separation efficiency and the on-line processing time of the system. The net result is a cost-effective waste oil recovery system which minimizes both downtime and operating costs while maximizing product recovery. (See also W89-02006) (Lantz-PTT)
W89-02051

USE OF PEAT IN THE TREATMENT OF OIL-IN-WATER EMULSIONS,
Regina Univ. (Saskatchewan). Faculty of Engineering.
T. Viraraghavan, and G. N. Mathavan.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 465-474, 10 fig, 3 tab, 20 ref.

Descriptors: *Peat, *Wastewater treatment, *Oil, *Emulsions, Grease, Performance evaluation, Isotherms, Kinetics, Adsorption, Filtration.

Apart from activated carbon, several other natural and synthetic media can be used to absorb oil and grease. Due to its abundant availability, peat lends itself as a potential medium for the removal of oil and grese from various wastewater streams. The oil binding capacity of the Saskatchewan horticultural peat was found to be 7.5 to 7.8 times its weight. The kinetic studies indicated that equilibrium was reached within 1 to 3 hours of contact between the peat and oil-in-water emulsions depending upon the nature of the oil used and the emulsion stability. The adsorption data for the emulsions did not follow the Langmuir and the Freundlich isotherms. Generally, the Branaur-Emmett Teller isotherm appeared to fit the data letter. Column studies indicated that peat is capable of adsorbing oil to an extent of 90% for more than eight hours of continuous run without necessitating backwashing. However, the time up to which peat can be used without backwashing is to be investigated. The average percentage removal in the column for the four emulsions studied at a flow rate of 12 ml/min for two cycles of eight hours each were as follows: standard mineral oil, 99.59%; Midale crude oil, 99.48%; cutting oil, 96.90%; and refinery effluent 91.32%. The study indicated that the peat columns can take higher flow rates and longer filter runs than the flow rate of 12 ml/min and eight hours of filter run studied. (See also W89-02006) (Lantz-PTT)
W89-02052

START-UP AND OPERATION RESULTS FROM SBR TREATMENT OF A MEAT PROCESSING WASTEWATER,
Jet Tech, Inc., Industrial Airport, KS.
K. L. Norcross, S. Petrie, R. Bair, and G. Beaushaw.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 475-481, 5 fig, 2 tab, 1 ref.

Descriptors: *Wastewater treatment, *Sequencing batch reactors, *Meat processing industry, Industrial wastewater, Biological oxygen demand, Suspended solids, Grease, Flow rate, Hydrogen ion concentration, Performance evaluation.

The sequencing batch reactors (SBR) treatment plant at Doskocil Sausage Company was designed to remove BOD, suspended solids, and grease down to standard municipal waste concentration level of 200/200. The plant was designed as an SBR to provide some measure of control over the filaments which had plagued the existing fine-bubble diffused air activated sludge plant. The SBR plant was designed, constructed, and started up within 18 months. Within 4 weeks after start-up, BOD and grease removals exceeded 98%. Over the next 12 months, BOD and grease removal averaged 99%, and suspended solids removal averaged over 90%. Throughout that period, the sludge volume index has typically been 125 or less. Extreme variations in flow rate and pH have shown little effect on effluent quality. System operation has proven to be flexible, reliable, and simple. The plant employs one operator working 40 hours per week. The automatic process controller 'runs' the plant. Due to the savings on sewer disposal charges, Doskocil Sausage Company recovered its investment in < 18 months. (See also W89-02006) (Lantz-PTT)
W89-02053

PERFORMANCE OF WORLD'S LARGEST CYCLICAL ACTIVATED SLUDGE PROCESS TREATING COMBINED MUNICIPAL/PACKING HOUSE WASTEWATER,
Wauford (J.R.) and Co. Consulting Engineers, Inc., Jackson, TN.
K. S. Young.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 483-490, 5 fig, 5 tab, 2 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Cyclical activated sludge process, *Meat processing industry, *Municipal wastewater, Industrial wastewater, Decanting, Mixed liquor solids, Suspended solids, Performacne evaluation, Nitrates, Nitrogen.

The ICEAS variation of the cyclical actuated sludge process is a viable, cost-effective method for treating wastewaters containing conventional pollutants in volumes up to 6.0 mgd with peak flows up to 16.0 mgd to meet secondary effluent limits. Considerations to prevent short circuiting of influent during decantation in continuous influent-intermittent effluent cyclical activated sludge processes should include constant rate recantation if a pivoting gutter type decanter is used, tank length to width ratios in excess of 2:1, and shortening or eliminating the central transverse baffle provided to inhibit sludge migration during the decant cycle. Cyclical actuated sludge processes treating wastewaters with high concentrations of inert solids operating based on F/M loadings should use mixed liquor volatile suspended solids (MLVSS) for design loading calculations rather than mixed liquor suspended solids (MLSS). The ICEAS variation of the cyclical activated sludge process operated at F/M (MLVSS basis) loading of 0.15 and a sludge age (MLSS basis) of 10 days can provide consistent removal of over 90% of influent BOD and over 97% of influent NH3-N. (See also W89-02006) (Lantz-PTT)
W89-02054

DIOXIN: TREATMENT WITH OZONE,
Schmidding-Werke, Cologne (Germany, F.R).
D. Von der Mark, A. R. Joel, and H. H. Rump.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 499-507, 6 fig, 3 tab, 6 ref.

Descriptors: *Dioxins, *Ozonation, *Chemical treatment, *Wastewater treatment, Hydrogen ion concentration, Aqueous media, Ozone, Chemical reactions, Polychlorinated dibenzo-p-dioxins, Polychlorinated dibenzofurans, Temperature.

Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are almost inert in the presence of acids and alkali solutions and are, under certain conditions, chemically stable against oxidative and reductive reaction conditions, and are stable at high temperatures (several hundred degrees Celsius). Ozone, as a very strong oxidant, can react with PCDDs and PCDFs. The reaction behavior of various PCDDs and PCDFs in an aqueous medium with ozone was studied. No significant degradation of 2,3,7,8-T4CDD by ozone was observed at pH 5 in an aqueous medium. At pH 10, ozone will react with PCDDs and PCDFs in an aqueous medium. The degradation of PCDDs and PCDFs was found to be a second order reaction. Rate constants were calculated for selected PCDDs and PCDFs. The degradation reaction is more rapid at 50 C than at 20 C. Ozone will react with 2,3,7,8-T4CDD in a typical dump leachate, with pH adjusted to 10. (See also W89-02006) (Lantz-PTT)
W89-02056

SENSITIZED PHOTOOXIDATION OF BROMACIL: PILOT, BENCH, AND LABORATORY SCALE STUDIES,
Tennessee Technological Univ., Cookeville.
T. N. Eisenberg, E. J. Middlebrooks, and V. D. Adams.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 509-518, 11 fig, 4 tab, 11 ref.

Descriptors: *Photooxidation, *Bromacil, *Wastewater treatment, Herbicides, Oxidation, Chemical treatment, Hydrogen ion concentration, Detoxification, Temperature, Light intensity, Pilot plants, Performance evaluation, Design criteria.

The objective of this study was to develop information to design a full scale sensitized photooxidation for bromacil detoxification in a full scale field situation; determine the effects of mixing, sunlight intensity, pH value, reactor depth, sensitizer and sensitizer concentration, initial substrate concentration, dissolved oxygen concentration, water and air temperature, suspended solids and turbidity, and hydraulic detention time on detoxification efficiency; screen a variety of dyes and stains for potential sensitizers and determine the effect of pH value on the reaction rate for the sensitizers; and develop mathematical models to predict and optimize detoxification efficiencies. Degradation of bromacil was directly related to percent ionization, and both were dependent on pH value. A pH value above 9 was necessary to ensure maximum reaction rates using methylene blue as a sensitizer. A methylene blue concentration in the range from 1 to 10 mg/L was sufficient to photooxidize a 30 mg/L bromacil solution. Reaction rates were highest at 10 mg/L, and at higher concentrations reaction rates began to decline. Some removal of bromacil and methylene blue was due to adsorption onto and subsequent settling out of suspended solids. The sunlight intensities encountered during the study, 294 to 876 W/sq m, were sufficient for degradation for degradation of bromacil. Air temperatures (0 to 35 C), and wastewater temperatures (10 to 25 C) did not affect reaction rates. In laboratory studies to screen potential sensitizing agents, little or no bromacil degradation was observed at a pH value of 4. An increase in reaction rate was seen at pH 7, and reaction rates were highest at pH 10. (See also W89-02006) (Lantz-PTT)
W89-02057

COMPARATIVE EVALUATION OF ALTERNATIVE HALOGEN-BASED DISINFECTION STRATEGIES,
Purdue Univ., Lafayette, IN. School of Civil Engineering.
J. E. Alleman, J. E. Etzel, D. Gendron, E. J. Kirsch, and J. Conley.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 519-524, 4 fig, 2 tab, 25 ref.

Descriptors: *Disinfection, *Halogens, *Wastewater treatment, *Comparison studies, *Bromination, Chlorination, Hydrogen ion concentration.

Bromine-based disinfection has been recognized as having a number of advantages compared to chlorine, including: (1) bromamines provide bacteriocidal effects comparable to free hypobromous acid; (2) bromamine species are short-lived (i.e. with half-lives measured in minutes); (3) bromine-based disinfection remains effective more than one pH unit higher than Cl2; and (4) bromine-based disinfection has been shown to provide improved disinfection of viruses, cysts, and certain bacteria, as compared to equivalent chlorine doses. Disinfection results obtained during a controlled laboratory evaluation of two alternative bromine-based disinfection procedures in comparison with chlorine-only treatment are reported. The two bromine-based strategies were as follows: (1) sodium bromide supplementation during chlorine disinfection; and (2) the use of bromochlorodimethylhydantoin (BCDMH), and organic compound carrying both of the oxidizing halogen species. The results obtained during the reported study inherently reinforce the findings of other researchers studying the comparative performance of bromine-based vs. chorine-based disinfection, and consequently warrant the future promotion of bromine-based disinfection as an effective, appropriate alternative treatment strategy. In particular, bromine-based disinfection appears to be advantageous in those situations requiring minimal residuals, due to both the relative effectiveness of this procedure and the expedient decay characteristics of the constitutive

bromine species. (See also W89-02006) (Lantz-PTT)
W89-02058

CHEMICAL ENHANCEMENT AND DEPRESSION OF OXYGEN TRANSFER IN INDUSTRIAL WASTEWATERS,

Northeastern Univ., Boston, MA. Dept. of Civil Engineering.
R. C. Backman, F. C. Blanc, F. J. Siino, and J. C. O'Shaughnessy.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 525-540, 11 fig, 5 tab, 28 ref.

Descriptors: *Chemical treatment, Oxygen transfer, *Industrial wastewater, *Wastewater treatment, Aeration, Comparison studies, Organic compounds, Surfactants, Pilot plants, Performance evaluation, Biological treatment.

Oxygen transfer capabilities were tested in the presence of specific organic compounds. The effects on oxygen transfer of several organic compounds and surfactants were examined in jet aeration and five bubble dome aeration set-ups. Although the data collected in this study apply only relative to the systems used, the trends observed are definitely indicative of what could be seen in full scale operations. For both aerators one area that is not directly addressed in this study is the effect of liquid depth on oxygen transfer. It has been shown that oxygen trasnfer efficiencies definitely increase with depth for clean water. The enhancement shown for the jet aerator has been indicated for full scale systems but further research is required before definitive conclusions can be made. Preliminary results on active biological systems containing the types of chemical compounds used in this study indicate enhancement of oxygen transfer in steady state systems using jet aerators. Also, acive biological systems using fine bubble dome aeration seem to benefit from trace amounts of carboxylic acid and alcohols. (Lantz-PTT)
W89-02059

DISSOLVED OXYGEN CONTROL IN A COUPLED FLUIDIZED BED SYSTEM,

Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
R. M. Jones, and H. Melcer.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 541-549, 11 fig, 13 ref.

Descriptors: *Dissolved oxygen, *Process control, *Coupled fluidized bed, *Wastewater treatment, Model studies, Control systems, Fluidized bed process.

A specific operating problem existed relating to the control of the dissolved oxygen concentrations in the oxygenic reactor of a coupled biological fluidized bed process. The first step in solving the control problem was the formation of a dynamic model for the response of the oxygenic reactor effluent DO concentration to changes in a control signal regulating the oxygen supply to the reactor feed. The second step was the design of an appropriate controller based on the dynamic model. The third step was the implementation of the controller. The main difficulty in controlling the process was related to the significant amount of deadtime in the DO response. The process response also seemed to change over time, and the dynamic model parameters required readjusting after the process modeling stage. A proportional-integral (PI) controller with a Smith Predictor deadtime compensator was considered to be successful for the purpose of controlling the pilot plant DO concentration during dynamic experimentation. The controller maintained a steady DO concentration at a setpoint of 2.5 mg/L. After a disturbance, steady control was usually reestablished at the setpoint of 2.5 mg/L. After a disturbance, steady control was usually reestablished at the setpoint within 40 minutes. Since the success of the Smith Predictor scheme depends on a good model, a major proportion of the time spent in developing the controller was consumed in model identification. After the initial identification, more time was required in monitoring the adequacy of the model and making required parameter adjustments. These difficulties could be overcome in future applications by using a self-tuning controller which would automatically estimate the required parameters online. To improve the disturbance regulation of a DO controller, a method would be required to measure an impending disturbance before it propagated through the process. A feed forward control element could then be added to the overall control scheme which would take corrective action on the process before the disturbance caused the process output to deviate. (See also W89-02006) (Lantz-PTT)
W89-02060

SOLIDS SETTLING VARIABILITY IN ACTIVATED SLUDGE SECONDARY CLARIFIERS: EFFECT ON OPERATION AND CAPACITY,

Vermont Univ., Burlington. Dept. of Civil and Mechanical Engineering.
J. W. Morris, L. A. Batchelder Adams, and H. G. Tozer.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 551-564, 8 fig, 6 tab, 34 ref.

Descriptors: *Settleable solids, *Activated sludge process, *Secondary wastewater treatment, *Clarification, Wastewater treatment, Biological treatment, Fluctuations, Mathematical studies.

Solids settling variability and its actual and potential operating influence, were studied at three operating municipal wastewater treatment facilities. Solids settling variations were appreciable on the basis of every parameter (flux variability (delta G); gravity flux curve (V sub o and k); minimum total solids flux loading (G sub s); and time requirement per unit depth of storage, time/length (T sub x)) observed during this experimental program. Describing gravity solids-flux variability using changes in the settleability signature V sub o and k values appear appropriate. The operationally significant solids separation capacity and the resultant impact of variability may be described using the derived parameters G sub s and T sub x. Facility design limitations constrain operation RAS flow to values appreciably greater than optimum for the majority of days analyzed. This points out the need for operating design flexibility. Overall efficient solids handling capacity measured as G sub s was relatively consistent at all three experimental sites. Average G sub s values were: Plant 1 - 89 kg/sq m/d, Plant 2 - 57 kg/sq m/d, and Plant 3 - 37 kg/sq m/d. (See also W89-02006) (Lantz-PTT)
W89-02061

REMOVAL OF SELECTED PRIORITY POLLUTANTS USING A PILOT-SCALE MODIFIED ACTIVATED SLUDGE PROCESS,

Rhode Island Univ., Kingston. Dept. of Civil and Environmental Engineering.
L. T. Thiem, and S. Al-Muzaini.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 565-571, 24 fig, 1 tab, 8 ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Priority pollutants, *Refinery wastewater, *Oil wastes, Biological oxygen demand, Chemical oxygen demand, Organic carbon, Activated carbon, Dimethylphenol, Phthalates, Fluorene, Naphthalene, Pyrene, Benzene, Chloroform, Ethylbenzene, Toluene, Xylene, Pilot plants, Performance evaluation.

Conventional activated sludge biomass can be acclimated to accomplish successful treatment of a refinery wastewater. The activated sludge treatment process was capable of removing conventional pollutants such as BOD, COD, and TOC, as well as selected priority organics (dimethylphenol, phthalates, fluorene, naphthalene, pyrene, benzene, chloroform, ethylbenzene, toluene, xylene) present in a refinery wastewater. Powdered activated carbon concentrations up to 150 mg/L in the activated sludge reactor enhanced removals of both the conventional and selected priority pollutants. Changes in the sludge age between 3 and 12 days had little effect on the removal efficiencies for the compounds studied. (See also W89-02006) (Lantz-PTT)
W89-02062

METHODOLOGY FOR UTILIZING RESPIROMETRIC DATA TO ASSESS BIODEGRADATION KINETICS,

Delaware Univ., Newark. Dept. of Civil Engineering.
A. F. Gaudy, A. F. Rozich, S. Garniewski, N. R. Moran, and A. Ekambaram.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 573-584, 9 fig, 4 tab, 21 ref.

Descriptors: *Data interpretation, *Activated sludge process, *Process control, *Wastewater treatment, *Biodegradation, *Kinetics, *Mathematical studies, Mathematical analysis, Respiration, Biomass, Growth rates, Oxygen, Wastewater analysis, Biological treatment.

It is reasonable to assume that the carbon source in the activated sludge process is removed from solution during metabolism and then channelled in varying proportions into synthesis of new cells and to respiration measurable as oxygen uptake. The principle may be employed to calculate one of the three variables in the process if reliable information can be obtained on the remaining two. Previous studies have applied this principle to obtain growth curves from oxygen uptake data for both metabolically simple (EMP and TCA) and metabolically complex systems. This paper mathematically illustrates that the accumulated oxygen uptake curve can be employed quite readily as a surrogate for the growth curve in defining the relationship between growth rate and oxygen demand. Analytical considerations are discussed and results are presented of a test of the respirometric method in a laboratory-scale activated sludge batch reactor. The results show that the 02 surrogate method for obtaining specific growth rates at various initial concentrations of substrate provides results that are essentially identical to those obtained in growth studies. (See also W89-02006) (Lantz-PTT)
W89-02063

ACTIVATED SLUDGE TREATMENT OF SELECTED AQUEOUS ORGANIC HAZARDOUS WASTE COMPOUNDS,

Cincinnati Univ., OH. Dept. of Civil and Environmental Engineering.
M. K. Koczwara, J. E. Park, R. J. Lesiecki, and D. W. Grosse.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 585-592, 1 fig, 6 tab, 5 ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Organic compounds, *Hazardous wastes, Methyl ethyl ketone, Trichloroethane, Biodegradation, Biological treatment, Volatilization, Stripping, Biomass.

Prior to testing industrially generated hazardous wastes, two prototype bench-scale activated sludge systems have been set up and are being used to evaluate the fates of two selected aqueous organic hazardous waste constituents, methyl ethyl ketone (MEK) and 1,1,1-trichloroethane (TCA). The primary removal mechanism for MEK in an acclimated activated sludge system at the concentration studied (55 + or - 9 mg/L and 430 + or - 59 mg/L) appears to be biodegradation. In addition, stripping may become an increasingly important removal mechanism as the concentration of MEK is raised further. This phenomenon is currently being investigated. The effect of the studied concentrations on the operation of a full scale activates sludge plant is not clear as a result of solids settling/return problems experienced during this phase of the study. The primary removal mechanism for TCA appears to be volatilization/strip-

ping. Some biodegradation was evidenced, but it is not likely to be an important removal mechanism, especially at higher concentrations, due to TCA's inhibitory effects on biomass growth. (See also W89-02006) (Lantz-PTT)
W89-02064

IMMOBILIZED MIXED MICROBIAL CELLS FOR WASTEWATER TREATMENT,
Hawaii Univ. at Manoa, Honolulu. Dept. of Agricultural Engineering.
P. Y. Yang, T. Cai, and M. L. Wang.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 593-605, 22 fig, 1 tab, 4 ref.

Descriptors: *Entrapment, *Cells, *Wastewater treatment, Microbiological studies, Filters, Filtration, Calcium alginate, Cellulose triacetate, Organic compounds, Solids retention time, Nitrates, Nitrogen, Chemical oxygen demand.

Studies of entrapped microbial cells for wastewater treatment processes are necessary for overcoming and to provide an effective removal or degradation of organic-toxic materials. One way in which the effective entrapment of microbial cells in the carrier is revealed is by calculating the mass balance of NH4-N for estimating SRTs (Solid Retention Time). These SRT's may be estimated through the amount of NH4-N retained in the carrier divided by the amount of NHr-N discharged from the system per day. The increase of SRT indicates that the microbial cells gradually divide in the entrapped carrier. The stable operational performance is expected when the higher SRT's are maintained. The SRT gradually increases as the day of operation increases. After 5 days of operation, SRT can be increased to about 9 days which is in the range of the operation of activated sludge process (SRT = 5-15 days) but not the extended aeration process (20-30 days). Furthermore, the present process of using the mono-carrier can increase the SRT to more than 30 days after 8 days of starting-up period. Both TCOD and SCOD removal efficiencies are above 92% after 10 days of operation. The benefit of entrapping microbial cell in a mon-carrier for improving organic wastewater treatment process is guaranteed. However, with the higher loading rates (3.0 - 9.0 g COD/L/day) applied in a bi-carrier system, the SRT could be only maintained in the range of 2 to 40 days when periodical column washing was conducted. In spite of the higher loading rate applied, after 20 days of operation, the SRT could still be maintained in the range of 8-15 days. (See also W89-02006) (Lantz-PTT)
W89-02065

ENHANCED TREATMENT OF HIGH STRENGTH SOFT DRINK BOTTLING WASTEWATERS,
Worcester Polytechnic Inst., MA. Dept. of Civil Engineering.
J. C. O'Shaughnessy, F. C. Blanc, S. H. Corr, and A. Toro.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 607-617, 4 fig, 8 tab, 1 ref.

Descriptors: *Food-processing wastes, *Wastewater treatment, *Industrial wastewater, Biological oxygen demand, Potassium, Nitrogen, Phosphorus, Settleable solids, Aeration, Wastewater lagoons, Massachusetts, Bottling plants.

The Coca Cola Bottling Company of Cape Cod began production at a new facility in Sandwich, Massachusetts in 1984. The Department of Environmental Quality Engineering required that company construct an on-site treatment facility to handle the discharge from the bottling operation. That facility was designed to achieve effluent quality of < 20 g/L BOD and TSS prior to discharging into the ground. The design of the wastewater treatment system was based on pilot plant work conducted on wastewater effluent from the old production facility in South Sagamore. That work indicated that a thirty-day detention time with aeration would reduce the influent BOD from 1200 mg/L to between 5 and 10 mg/L. The pilot study had indicated that treatment efficiency and settleabilities could be improved through the addition of a supplemental nutrient. Phosphorus and nitrogen had been added in the form of phosphoric acid and aqueous ammonium since the plant had been placed into operation. During the first week of June 1986, the addition of potassium in the form of potash (60% K2O fertilizer) to Lagoon No. 1 and Lagoon No. 2 had been initiated. By late June, the BOD concentration in Lagoon No. 1 had decreased to 60 mg/L from a peak value of 620 mg/L during early May. In Mid-June, a 5.0 HP jet-type aerator was installed in Lagoon No. 2. By early August, the BOD concentration in Lagoon No. 1 had decreased to below 20 mg/L. However, BOD concentrations in Lagoon No. 2 remained high because the aerator in Lagoon No. 2 not only increased the oxygen supply, but also resuspended the solids that had settled to the bottom. The solids were the settleable solids which were produced in Lagoon No. 1 and carried over to Lagoon No. 2. The mixing action brought about breakdown of the solids, causing the BOD concentrations in Lagoon No. 2 to remain high. As a result of the potassium nutrient addition and the aerator addition to Lagoon No. 2, the treatment plant has been able to meet discharge permit limitations through the end of 1986. Lagoon No. 1 has been achieving BOD removals of > 99%. Plant raw waste BOD concentrations in Lagoon No. 1 averaged between 15 and 25 mg/L since mid-September. (See also W89-02006) (Lantz-PTT)
W89-02066

BIOGASIFICATION OF SORGHUM IN A NOVEL ANAEROBIC DIGESTER,
Institute of Gas Technology, Chicago, IL.
V. J. Srivastava, R. Biljetina, H. R. Isaacson, and T. D. Hayes.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 619-627, 7 fig, 5 tab, 10 ref.

Descriptors: *Methane production, *Energy sources, *Anaerobic digestion, *Biogasification, *Sorghum, *Wastewater treatment, Biomass, Methane, Organic matter, Digestion, Biological wastewater treatment, Agricultural wastes.

Sorghum represents a potentially large biomass resource for conversion to methane. A total of 17.8 million acres of sorghum were planted in the U.S. in 1985 with the growth yield of as high as 36 tons (fresh weight)/acre/yr. Biogasification data collected at mesophilic conditions in a single stage, solids concentrating digester suggest that this is an excellent material for conversion to methane. Methane yields of 5.3 SCF/lb organic matter fed were obtained at a loading rate of 0.27 lb of organic matter/cu ft/day. This represents nearly complete conversion of the biodegradable portion of the sorghum and exceeds the yields nearly complete conversion of the biodegradable portion of the sorghum and exceeds the yields obtained in a conventional CSTR by 50%. Increased methane production rate, 2.0 vol/vol/day, was obtained during the thermophilic operation of the ETU. Average methane yield during this period was 4.4 SCF/lb organic matter added at a loading rate of 0.47 lb of organic matter/cu ft/day. With further optimization it may be possible to increase the methane yields even further in the solids concentrating digester. These studies have generated a data base for the conversion of sorghum to methane at a scale sufficiently large to establish commercial operating parameters and to provide the data necessary for economic evaluations. (See also W89-02006) (Lantz-PTT)
W89-02067

CHARACTERISTICS OF RESIDUES FROM THERMALLY TREATED ANAEROBIC SLUDGES,
Syracuse Univ., NY. Dept. of Civil Engineering.
A. A. Friedman, J. E. Smith, J. DeSantis, T. Ptak, and R. C. Ganley.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 629-646, 16 fig, 4 tab, 32 ref. New York State Energy Research and Development Authority Contract 704-RIERI-BEA-85.

Descriptors: *Waste characteristics, *Anaerobic digestion, *Sludge, *Wastewater treatment, *Thermal treatment, Sludge drying, Oxidation, Wet air oxidation, Suspended solids, Chemical oxygen demand.

Wet air oxidation followed by the dewatering of residual solids can be used to significantly reduce the volume of anaerobic sludges (> 965). If decant liquors are to be treated by anaerobic methods for reducing the main stream plant loading, the choice of wet air oxidation (WAO) operating condition is critical. The use of high reactor temperatures (> 250C) generates toxic or inhibitory factors such as formaldehyde; lower WAO temperatures result in reduced volatile suspended solids (VSS) destruction and more residual solids for final disposal. An optimum WAO operating temperature appears to be 230 C at which 65.5% of the VSS is destroyed and about 60% of the SCOD generated is biodegradable. The research revealed that most of the heavy metals present in raw PDS, with the exception of mercury, were concentrated in the dewatered solids. Settled and/or dewatered WAO volatile solids have a much higher COD content (g COD/g VSS) than raw previously digested sludge (PDS) regardless of the operating temperature. The anaerobic bioassays were conducted over longer periods with more frequent chemical analyses of constituents than normally reported. These techniques provided a better understanding of toxic effects and delayed methanogenesis than the common short term bioassay. (See also W89-02006) (Lantz-PTT)
W89-02068

AEROBIC CONTACT PRETREATMENT OF SLAUGHTERHOUSE WASTEWATER,
Foth and Van Dyke and Associates, Inc., Green Bay, WI.
M. N. Macaulay, T. W. Stebor, and C. L. Berndt.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 647-655, 1 fig, 2 ref.

Descriptors: *Anaerobic digestion, *Pretreatment of wastewater, *Meat processing industry, *Food-processing wastes, *Wastewater treatment, Chemical oxygen demand, Suspended solids, Mixed liquor solids, Biological oxygen demand, Nitrogen, Potassium, Methane, Temperature, Pilot plants.

Packerland Packing Co., Inc., a high volume beef processor, operates with the following primary sources of wastewater flow: washings from the kill floor, washwater from intestine flushing and casing production, paunch liquor from processing stomach contents, tripe wash, and rendering plant wastewater. As of mid-1984, Packerland was faced with significant operating costs associated with maintenance of its pretreatment plant and uncertain disposal opportunities for its semi-solid residuals (Pretreatment plant sludge, paunch solids). Consequently, Packerland sponsored a study of potential treatment system improvements. The study exposed many major deficiencies in the wastewater pretreatment system. Pilot studies were conducted, and included: Both the application of a mesophilic anaerobic contact process to the process wastewater and application of a thermophilic digestion process to the paunch manure and other miscellaneous semisolid residues generated in slaughterhouse production. Judging from the pilot plant results, the startup time for a full-scale system would be in the range of 8-10 weeks. Also, it was felt that an initial reactor mixed liquor volatile suspended solids concentration of 200-300 mg/L would be adequate for full-scale startup. Other full-scale recommendations from extrapolation of the pilot data included: (1) design the anaerobic reactor at a COD loading of 3.0 kg/cu m/day; (2) use an equalization tank to smooth out hydraulic fluctuations; (3) caustic or nutrient addition would not be required in the full-scale plant;

(4) a degasification method should be included which would improve performance of solids-liquid separation; (5) waste solids handling in the full-scale plant should be based on an expectation of 0.09 lb of total suspended solids produced per pound of COD added. (See also W89-02006) (Lantz-PTT)
W89-02069

FEASIBILITY OF PACKED-BED ANAEROBIC TREATMENT OF POULTRY PROCESSING WASTEWATER,
Georgia Technical Research Institute, Environmental, Health and Safety
S. R. Harper, G. E. Valentine, and C. C. Ross.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 657-671, 9 fig, 10 tab, 8 ref.

Descriptors: *Food-processing wastes, *Anaerobic digestion, *Wastewater treatment, *Wastewater management, *Poultry, Dissolved air flotation, Economic aspects, Industrial wastewater, Costs, Feasibility studies.

Since operational costs are the most significant part of overall treatment costs, suggestions for decreasing these costs, for either a dissolved air flotation (DAF) or an anaerobic option, are appropriate. If a significant service life remains on an existing DAF unit, such that converting to anaerobic treatment is not currently attractive, then measures should be taken to control chemical usage and excess sludge production. For this purpose, more routine flocculation testing (jar tests) are recommended together with better pH control. Low-cost sludge dewatering units would also be recommended provided they do not require high chemical dosages or extensive additional manpower. If a poultry processor is considering installing a wastewater pretreatment system (i.e. new plant, major expansion or replacement of outdated unit), it is highly recommended that an anaerobic treatment system be evaluated. Moreover, to help reduce the major operational cost of anaerobic treatment, i.e., process heating, the implementation of heat exchangers is suggested for recovery of low-grade heat wasted at a number of points in the poultry processing line. It is conceivable that the heating cost could be reduced by 75%, with payback for the heat exchangers in less than a year. The anaerobic treatment process has been demonstrated technically feasible in the laboratory, and economic projections show that it is economically competitive; in fact, significantly more attractive, than DAF treatment. The pursuit of pilot-scale and full-scale treatment endeavors is strongly recommended to help identify the operational intricacies and ultimate profitability of anaerobic treatment of poultry processing wastewater. (See also W89-02006) (Lantz-PTT)
W89-02070

ANAEROBIC TREATMENT OF A BEEF PROCESSING PLANT WASTEWATER: A CASE HISTORY,
AC Biotechnics, Inc., West Woodbury, NY.
C. R. Kostyshyn, W. A. Bonkoski, and J. E. Sointio.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 673-692, 23 fig, 6 tab, 5 ref.

Descriptors: *Food-processing wastes, *Anaerobic digestion, *Case studies, *Meat processing industry, Industrial wastewater, Chemical oxygen demand, Biological oxygen demand, Suspended solids, Methane, Pilot plants.

Packerland Packing Company (PPC) operates a high-volume beef processing/rendering plant in Green Bay, Wisconsin. At processing levels of 2300 head/day the plant produces approximately 10274 kg BOD with 8221 kg SS in 3050 cu m/day of raw wastewater. By 1984 the high costs for chemicals required to operate the existing physical/chemical wastewater pretreatment process, combined with steep municipal surcharges, prompted PPC to investigate more efficient and economical treatment alternatives. The wastewater produced by PPC's beef processing and rendering plants is highly amenable to anaerobic treatment. High treatment efficiencies in COD, BOD and TSS reduction are possible for this wastewater using the contact type anaerobic digestion system. Good COD to biogas conversion occurs with the production of biogas with a high methane (fuel) content. Excellent digester biochemical stability was observed without the addition of nutrients or pH neutralization chemicals. Excellent restart responses to both short (2 day) and intermediate (3 week) length shutdowns were observed. Solids production was F/M ratio dependent and averaged .13 TSS/kg COD added during Phase II. Prehydrolysis of the wastewater solids before the anaerobic reactor was neither significant nor necessary. Good solids settleability was observed during the entire pilot program, including high shock loadings, extended high loadings and high F/M ratio stresses. Start-up was rapid and trouble free using readily available municipal digester seed sludge. The pilot plant demonstrated the technical feasibility for full-scale treatment of this wastewater and provided the database on which to make an evaluation of the economics of such a facility relative to PPC's operations. (See also W89-02006) (Lantz-PTT)
W89-02071

ANAEROBIC PILOT PLANT STUDIES FOR DAIRY PLANT WASTEWATERS,
Stover and Associates, Stillwater, OK.
E. L. Stover, and R. Gonzalez.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 693-700, 4 fig, 4 tab.

Descriptors: *Anaerobic digestion, *Pilot plants, *Dairy industry, *Food-processing wastes, *Wastewater treatment, Industrial wastewater, Biological treatment, Nickel, Copper, Cobalt, Molybdenum, Chemical oxygen demand, Kinetics, Filtration, Hydrogen ion concentration, Methane, Flocculation.

The key to maintaining process control and stable operations in biological treatment systems (aerobic or anaerobic) is to provide proper environmental conditions to the biomass or bacteria in the system. Accurate biological kinetic analysis procedures were developed for anaerobic systems that allow comparison of wastewater treatability characteristics whether in full-scale or pilot treatment system. This approach has been successfully used to compare full-scale operations with pilot study data. The biological treatment kinetics indicated excellent anaerobic treatment characteristics. Micronutrient addition (Ni, Co, Cu, and Mo) at 0.1 mg/L based on forward flow did not improve the biological kinetics. Addition of cultured bacteria did not improve the biological kinetics. Operating the pilot reactor at full flow and COD loading conditions did not affect the biological kinetics. Feeding ultrafiltration permeate instead of whey did not affect the biological kinetics. Mixed liquor pH < 6.8 had detrimental impacts on biological kinetics. Micronutrient addition (Ni, Co, Cu, and Mo) significantly enhanced the methane gas production rate. Methane gas production rate was negatively impacted at mixed liquor pH < 6.8. Addition of cultured bacteria had no impact on gas production rate. Ultrafiltration permeant had no affect on the methane production rate. Gas quality (% methane) remained approximately the same at 55 to 60% methane in all the reactors irrespective of environmental conditions, micronutrient additions, or cultured bacteria additions. Methane production with micronutrient additions was around the theoretical value at 5.5 to 6.0 cu ft CH_4/lb COD removed. Methane production rates without micronutrients was typically around 60% of the theoretical value. Sludge flocculation characteristics were not as good with micronutrients. Macronutrients (N and P) were always present in excess of biological requirements. (See also W89-02006) (Lantz-PTT)
W89-02072

ANAEROBIC TREATMENT OF DAIRY WASTEWATER,
ADI Ltd., Fredericton (New Brunswick).
R. C. Landine, G. J. Brown, A. L. Steeves, W. A. Bough, and E. Bybee.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 701-705, 2 fig, 5 tab, 1 ref.

Descriptors: *Anaerobic digestion, *Dairy industry, *Wastewater treatment, *Food-processing wastes, Industrial wastewater, Biogas, Odors, Methane, Sulfur, Chemical oxygen demand.

In 1984 Mid-American Dairymen was faced with a need to upgrade the waste treatment facilities at its processing plant located in Monett, Missouri. The plan manufactures a variety of whey and several types of cheese. Mid-America Dairymen own a number of dairies, and this particular operation is considered to have the most difficult wastewater of the group of plants. The first treatment system and its later additions, were unable to completely resolve problems of odors emitted from the trickling filter system. New property located one-half mile away was purchased in March 1984. Construction of facilities began at the new site in mi-1984; the facilities consisted of a biotower, solids-contact clarifier, two sludge digestion basins and sludge decant tank equipped for lime addition. In early 1985, ADI International was commissioned by Mid-America Dairymen to carry out an onsite pilot study using the ADI-BVF low-rate technology. At the same time, ADI was retained to carry out detailed design. Upon completion of design in May 1985, the results of the pilot study confirmed that the process should work satisfactorily. The new aerobic plant was ready for start-up in April 1985, while construction of the ADI-BVF system commenced in June 1985. During the first week of operation, the reactor received raw wastewater for two hours/day (about 25,000 gal) with the remaining flow going to the trickling filter plant. During this start-up period, increasing amounts of waste aerobic sludge were pumped to the reactor, rather than to the aerobic digesters. In Mary 1987 the daily biogas production averaged 105,000 cu ft at 61% methane. The specific generation rate was 5.3 cu ft/lb COD destroyed. THe H_2S concentration in the biogas is rather high running at 0.5 to 1.5% as a result of high concentration of sulfur in the wastewater. Calculations revealed 120 lb of H_2S in the biogas, 225 lb H_2S dissolved in the effluent, an estimated 50 lb in proteins and other biopolymers, and an estimated 65 lb of elemental sulfur plated out on the biotower media and clarifier walls or in the form of metal sulfides. (See also W89-02006) (Lantz-PTT)
W89-02073

START-UP AND OPERATION OF AN ANAEROBIC FACILITY FOR PRETREATMENT OF CORN-ETHANOL WASTEWATER,
Biothane Corp., Camden, NJ.
J. Lanting, and R. L. Gross.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 707-715, 6 fig, 5 tab, 2 ref.

Descriptors: *Anaerobic digestion, *Wastewater facilities, *Corn, *Ethanol, *Wastewater treatment, Sludge, Chemical oxygen demand, Biological oxygen demand, Pretreatment of wastewater, Costs.

Based on 10 months of operating experience with a wastewater treatment plant at South Point Ethanol, a corn ethanol producer, the following was concluded: (1) In a design for an anaerobic digester system for pretreatment of corn-ethanol wastewater, one should account for the possibility of foaming, an apparent intrinsic property of this type of wastewater; (2) The addition of substantial equalization volume proved beneficial to the performance of the pretreatment system; (3) The BIOTHANE (an upflow anaerobic sludge blanket reactor) system handled loadings up to twice the design volumetric loading of 10 kg COD/ cu m/ day while maintaining treatment efficiencies in the range of 90 to 95% SCOD removal; (4) The combination of an anaerobic BIOTHANE system fol-

lowed by an aerobic trickling filter has provided excellent treatment for the wastewater from South Point Ethanol. Overall SCOD removals are about 97% and the soluble BOD removals are better than 99.5%; and (5) It appears that anaerobic pretreatment of this type of waste in a system of this size can be justified from a purely economic standpoint, when municipal surcharges exceed the equivalent of 11 cents/kg SCOD. (See also W89-02006) (Lantz-PTT)
W89-02074

HIGH-RATE ANAEROBIC WASTE TREATMENT - HOW HIGH,
Badger Engineers, Inc., Cambridge, MA.
A. M. Sobkowicz.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 717-726, 11 fig, 4 tab, 13 ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Upflow anaerobic sludge blanket, Fluidized bed upflow, Fixed bed filtration, Contact membrane processes, Pilot plants, Performance evaluation.

Information on the loading performance of full-scale commercial anaerobic systems is presented and compared with data published from pilot testing, in order to evaluate the extent to which the potential of the process to provide economical waste treatment has or has not been realized. The following high-rate anaerobic processes are discussed: upflow anaerobic sludge blanket (UASB), fluidized bed upflow, fixed bed filters-upflow and downflow, and contact-membrane process. The various investigators who have tested high rate anaerobic systems on the pilot scale have found that rates of up to 45 kg/cu m/day can be achieved on high strength wastes without dramatic reduction in system performance. Most of the full-scale systems that are currently operating are working in the range of 6 to 19 kg/cu m/day. The operators of these systems generally consider that the capability of the full-scale systems to handle higher loadings is untested, either because no additional waste is available to provide an extended period at higher loading, or because other constraints prevent higher loadings on the anaerobic process. (See also W89-02006) (Lantz-PTT)
W89-02075

EFFECTS OF ENVIRONMENTAL FACTORS ON ACID-PHASE DIGESTION OF SEWAGE SLUDGE,
Institute of Gas Technology, Chicago, IL.
M. P. Henry, A. Sajjad, and S. Ghosh.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 727-737, 2 fig, 10 tab, 9 ref. EPA Contract CR-809982-01-1.

Descriptors: *Wastewater treatment, *Sludge digestion, *Acid-phase digestion, Hydrolysis, Hydrogen ion concentration, Temperature, Acidification, Biological treatment, Thermophilic bacteria, Microbiological studies, Bacteria.

Anaerobic digestion of a particulate substrate, such as sewage sludge, consists of several separate fermentation steps that progressively degrade the substrate components to simpler intermediates and end-products. Each of these steps is mediated by distinct groups of bacteria. Particulate substrates are first hydrolyzed to monomers and then further reduced to volatile and nonvolatile fatty acids and other soluble intermediates, carbon dioxide, and hydrogen by acetogenic bacteria. The final step consists of conversion of acetate and carbon dioxide and hydrogen to methane by methanogenic bacteria. Feed hydrolysis and liquefaction efficiencies generally increased with culture pH and temperature, but were not significantly affected by retention time. Culture pH and the greatest impact on organic reductions, which were 14% to 23% higher in cultures operated at pH 7 than at pH 5. Carbohydrates reductions were influenced more strongly by pH than were lipids or crude protein reductions. Culture temperature influenced carbohydrate and crude protein reductions, but had no significant effect on lipid reductions. Gasification efficiencies were also influenced strongly by culture pH and temperature, but only slightly by retention time. Methanogenesis was retarded under acidic pH or thermophilic conditions. Acidification efficiencies were most strongly influenced by culture temperature and least by culture hydraulic retention time (HRT). Acid-phase digestion of particulate substrates was optimized in thermophilic cultures operated at near neutral pH and at HRT's of 2 days or less. (See also W89-02006) (Lantz-PTT)
W89-02076

TOXICITY OF SULFIDES TO THE ANAEROBIC TREATMENT PROCESS,
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
B. L. Hilton, and J. A. Oleszkiewicz.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 739-747, 9 fig, 12 ref.

Descriptors: *Toxicity, *Sulfides, *Anaerobic digestion, *Wastewater treatment, Lactose, Methanogenesis, Suspended solids, Cell growth, Hydrogen ion concentration, Retention time, Sulfates, Methane bacteria.

A series of batch experiments was performed in 100 ml glass syringes incubated in a water bath at 35 C to test the effects of sulfides and unionized H2S upon three aspects of anaerobic digestion: lactose utilization, acetate uptake and methanogenesis, and sulfate reduction. The rate of lactose utilization decreases with increasing concentrations of unionized H2S. When acetate is the carbon source, cell growth as measured by volatile suspended solids decreased with increased concentrations of sulfides, regardless of pH. Therefore, the growth of cells is inhibited by the presence of sulfides as well as unionized H2S. Methanogenesis and acetate uptake were inhibited by increased concentrations of sulfides, regardless of pH. However, given sufficient time (increased retention time) at increased pH values, acetate uptake and methane production proceeded to completion. This suggests that longer retention times (SRT or HRT) as well as elevation of pH may be used to maximize methane production under conditions of high sulfide concentrations. Sulfate reduction is inhibited in proportion to the total sulfide concentration, product inhibition, rather than H2S toxicity. It was calculated that sulfate reduction completely ceased at 1100 mg S(2-)/l. The methanogenic bacteria are more sensitive to unionized H2S than the lactose utilizing bacteria. Elevated concentrations of sulfides in anaerobic reactors treating high sulfate concentrations were shown to affect lactose utilization, sulfate reduction, and methanogenesis. (See also W89-02006) (Lantz-PTT)
W89-02077

ANAEROBIC TREATMENT OF TANNERY WASTEWATER,
Suzhou Inst. of Urban Construction and Environmental Protection (China).
H. Yong.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 749-755, 12 fig, 2 tab, 6 ref.

Descriptors: *Anaerobic digestion, *Wastewater treatment, *Tannery wastes, Industrial wastewater, Chemical oxygen demand, Load distribution, Mathematical studies, Kinetics, Retention time, Performance evaluation.

The feasiblity of treating tannery wastewater with the anaerobic process was demonstrated. Using an influent COD of 8450 to 8600 mg/l and a volumetric loading of 1.2 to 2.9 kg COD/cu m/day, a COD removal of 60 to 70% could be obtained; under an influent COD of 2400 mg/l and a volumetric loading of 0.22 to 0.5 kg COD/cu m/day, the effluent COD was only 720 to 1270 mg/l. Generally, anaerobic treatment of tannery wastewater follows the rule of first-order reaction kinetics, K = 0.0000283. The key for improving the efficiency of treatment is to maintain a large amount of activated anaerobic sludge. It is desirable to increase the volumetric loading by means of applying a higher concentration of influent COD and retaining sufficient hydraulic retention time. Two to three days is suitable. It is suggested that the F/M ratio should be used as a parameter for process design and operation. (See also W89-02006) (Lantz-PTT)
W89-02078

ANAEROBIC PRETREATMENT OF HIGH STRENGTH WASTEWATERS USING A REACTIVE GROWTH SUPPORT MEDIA,
Transfield, Inc., Irvine, CA.
M. C. Goronszy, and W. W. Eckenfelder.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 757-765, 3 fig, 5 tab, 8 ref.

Descriptors: *Anaerobic digestion, *Wastewater treatment, *Growth media, Alkalinity, Retention time, Chemical oxygen demand, Biomass, Volatile acids, Load distribution.

A high density particulate alkalinity sensitive media can be used in an anaerobic reactor to provide high active mass retention and availability which enables operation at reduced hydraulic retention times. This investigation showed that around 70% reduction in COD of a synthetic potato wastewater could be obtained at equivalent volumetric loadings of around 3 kg COD/cu m/day with hydraulic retention of about 20 hours. The investigation also showed that biomass settlement properties were enhanced as a consequence of the high density reactive support growth media. For this operating condition, growth media usage was determined at around 1.4 g CaCO3/g COD reduced. The use of alkalinity sensitive growth media ensured a favorable volatile acid concentration (VFA)/alkalinity ratio at all times. This feature can be used to significantly minimize the impact of short term load fluctuations which can be detrimental to the long-term stability of anaerobic systems. The feasibility of operating an anaerobic reactor as a variable volume system in a similar manner to cyclically operated activated sludge systems, was established. (See also W89-02006) (Lantz-PTT)
W89-02079

CHARACTERIZATION, DEVELOPMENT AND USE OF NEW BREED OF ANION-EXCHANGE RESINS FOR SELECTIVE REMOVAL OF CR(VI) AND OTHER TOXIC ANIONS,
Lehigh Univ., Bethlehem, PA. Dept. of Civil Engineering.
A. K. Sengupta, T. Roy, D. Clifford, and S. Subramonian.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 793-801, 10 fig, 1 tab, 8 ref.

Descriptors: *Toxic wastes, *Anion exchange, *Resins, *Chromium, *Toxicity, *Wastewater treatment, Anions, Polystyrene, Hydrogen ion concentration, Chlorides, Arsenic, Nitrites, Selenium, Organic compounds.

Chromate ion exchange was studied for treatment of toxic wastewater in the presence of competing ions. Experimental results with commercially available anion-exchange resins indicate that those with more hydrophobic polystyrene matrix and an amine-functionality with a high steric hindrance property exhibit greater chromate selectivity in the presence of competing sulfate ions. At alkaline pH, on the other hand, an increased divinylbenzene crosslinking greatly improves the chromate selectivity. Based on these findings and proper scientific analysis of the experimental data, new resins have been synthesized with only minor modifications of some of the key properties of the commercial anion-exchange resins. Compared to the best available commercial products, these new resins greatly

improve the performance of the chromate-exchange process. However, identifying the best anion-exchange resin, for a given contaminant removal process, is greatly dependent on the nature and concentration of the competing ions and efficiency of regeneration. The choice of the best anion-exchange resin for Cr(VI) removal may be different when chloride is the major competing anion instead of sulfate. Characterizing and modifying important properties of anion-resins for better performance are not limited to only chromate ion exchange; similar approaches can also be made for selective removal of other contaminants, such as As(V), NO3(-), Se(VI), organo-arsenic compounds. (See also W89-02006) (Lantz-PTT)
W89-02084

IS THERE A ROLE FOR LIQUID ION EXCHANGE IN THE RECOVERY OF CHROMIUM FROM PLATING WASTEWATER,
Michigan State Univ., East Lansing. Dept. of Civil and Environmental Engineering.
M. L. Davis, M. Chang, D. Copedge, and M. Strong.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 803-807, 6 fig, 2 tab, 13 ref.

Descriptors: *Ion exchange, *Chromium, *Metal-finishing wastes, *Wastewater treatment, Hydrogen ion concentration, Mixing, Stripping, Kerosene, Settling, Sodium hydroxide.

The mechanism by which liquid ion exchange removes chromium from solution is similar to conventional resin ion exchange. Ions are transferred from the wastewater in exchange for transferable ions carried by the liquid ion exchange reagent. The liquid ion exchange reagent (extractant) is insoluble in water. The extractant is diluted with a carrier hydrocarbon solvent such as xylene or kerosene. The minimum parameters required for design of the liquid ion exchange process are: (1) optimum pH; (2) wastewater/extractant ratio; (3) mixing time; (4) mixing intensity; (5) settling time; (6) overflow rate; and (7) stripping solution/extractant ratio. Other factors of interest are chrome recovery efficiency, phase separation efficiency, extractant recovery (solvent loss) and sludge generation rates. The optimum pH, mixing time, settling time and stripping/extractant ratio have been determined. Work on the other parameters is still in progress. The pH was varied from 1 to 4. The experiment was repeated with sulfuric and hydrochloric acid. Both yielded the same result. A pH of 2 was selected as the design pH based on the extraction efficiency and the acid consumption. For the very high mixing speeds used in these initial studies (2,500 rpm), the optimum mixing time was found to be 2 minutes. The high mixing speed was selected by visual observation, i.e. when the extractant appeared to be well dispersed in the wastewater. Chrome rich solvent was mixed with 4N sodium hydroxide to strip the chrome from the solvent. Using a typical wastewater rinse bath flow of 30 gpm and the results from the experiments, the authors developed the following conceptual design: mixer - 60 gal, settler - 900 gal, stripper - 5 gal, settler - 15 gal. In addition, storage tanks for equalization and reagents would be required. Since the raffinate pH will be low, a neutralization step is required to allow the water to be discharged to a municipal sewer system. This study indicates that liquid ion exchange is a viable chromium recovery technique. (See also W89-02006) (Lantz-PTT)
W89-02085

COMPARATIVE EVALUATION OF HEAVY METAL IMMOBILIZATION USING HYDROXIDE AND XANTHATE PRECIPITATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
R. M. Bricka, and M. J. Cullinane.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 809-818, 7 fig, 3 tab, 9 ref.

Descriptors: *Heavy metals, *Wastewater treatment, *Hydroxides, *Xanthates, *Chemical precipitation, Cadmium, Nickel, Solidification, Mercury, Leaching, Solute transport, Chemical treatment.

The U.S. EPA estimates that there are over 13,000 generators of metal plating and finishing wastewaters. Treatment of these wastewaters, usually accomplished using some form of hydroxide precipitation, is estimated to generate approximately 11 million metric tons/yr of sludge requiring special handling and disposal. An alternative treatment method, developed by the U.S. Department of Agriculture, uses insoluble starch xanthates for the removal of heavy metals from wastewaters. Closer investigation reveals that an entire family of insoluble xanthates can potentially be used for waste treatment. Hydroxide precipitation is generally effective in a pH range of 9 to 12. Xanthate precipitation is effective for a pH range of 3 to 12. A previous study showed that xanthates selectively remove metals according to the following hierarchy: Na << Ca-Mg-Mn < Zn < Ni < Cd < Pb-Cu-Hg. Thus, xanthate precipitation methods offers several advantages over hydroxide precipitation. Unfortunately xanthate precipitation, like hydroxide precipitation, produces significant quantities of sludges that must be handled in accordance with the Resource Conservation and Recovery Act (RCRA). Of the heavy metals found in xanthate precipitated sludges, only Cd and Ni, for the unsolidified cellulose, showed tendency to leach. Solidification in most cases appeared to reduce the leachability of the heavy metals. Only Hg for the hydroxide sludges had increase in mobility upon solidification. Unlike the extraction procedure test, the serial graded batch extraction procedure is useful in determining the leaching potential of heavy metals from sludges. (See also W89-02006) (Lantz-PTT)
W89-02086

DEVELOPMENT OF DESIGN CRITERIA FOR TREATMENT OF METAL-CONTAINING WASTEWATERS AT OAK RIDGE NATIONAL LABORATORY,
Engineering-Science, Fairfax, VA.
G. C. Patrick, M. R. Hockenbury, W. T. Thompson, and J. M. Begavich.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 819-830, 10 fig, 8 tab, 4 ref.

Descriptors: *Design criteria, *Heavy metals, *Wastewater treatment, *Oak Ridge National Laboratory, Hydrogen ion concentration, Alkalinity, Lime, Sodium borohydride, Cadmium, Chromium, Copper, Nickel, Zinc, Sulfides, Flocculation, Chemical treatment, Clarification, Filtration, Performance evaluation, Pilot plants.

Bench scale treatability tests were performed to evaluate several metal removal processes. The tests showed that hydroxide precipitation at alkaline pH values (10.0 and above) using either lime or caustic achieved excellent removal of heavy metals. At a pH value of 10, the soluble metal concentrations measured for Cd, Cr, Cu, Ni and Zn were < 100 micrograms/l. Adding sodium borohydride to the precipitation reaction reduced the soluble metals concentration below the concentration measured for precipitation using either lime or caustic. Adding soda ash in combination with lime was shown to increase the soluble metals concentration as compared to precipitation using only lime. Finally, employing sulfide precipitation at the neutral pH values (7.6 to 10) appeared to be beneficial with respect to soluble metal concentration compared to hydroxide precipitation at neutral pH values. Batch settling and dewatering tests were performed to compare precipitation using caustic and lime. The floc formed by either lime addition and caustic addition settled readily. However, precipitation using lime generated considerably more sludge than precipitation using caustic. Both precipitation processes were tested by a 1.0 gpm continuous-flow pilot plant. The pilot plant employed pH adjustment, clarification and filtration. The effluent produced using either lime or caustic averaged < 50 micrograms/l for each metal analyzed (Cd, Cr, Cu, Ni, Pb and Zn). The pilot plant tests showed that filtration was necessary to achieve the low metals concentration. (See also W89-02006) (Lantz-PTT)
W89-02087

PRECIPITATION TREATMENT OF SPENT ELECTROLESS NICKEL PLATING BATHS,
Occidental Chemical Corp., Grand Island, NY. Grand Island Technology Center.
W. C. Ying, R. R. Bonk, and M. E. Tucker.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 831-846, 4 fig, 11 tab, 24 ref.

Descriptors: *Wastewater treatment, *Chemical precipitation, *Nickel, *Metal-finishing wastes, Industrial wastes, Ammonium citrate, Hydrogen ion concentration, Sodium borohydride, Chemical treatment, Metal complexes.

Nickel removal by precipitation as Ni(OH)2, Ni(0), and NiB2 was interfered with by the presence of organic acids which form stable nickel complexes. Ammonium citrate was the most powerful complexing agent employed in the six hypophosphite-reduced electroless nickel plating (EN) baths. pH adjustment using caustic soda was ineffective in removing Ni(II) from spent EN baths containing citrates. At pH = 10, hydroxide precipitation was unable to substantially lower the Ni(II) concentration from En baths containing either malic acid or aminoacetic acid. Nickel-aminoacetic acid complexes remained stable at pH = 12. Ni(II) was removed from all test solutions, as Ni(0) or NiB2, by reaction with sodium borohydride. In the precipitation treatment of EN baths, BH4(-) served both as a primary reducing agent and as a catalyst which initiated reduction by hypophosphite, as evidenced by the fact that the required dosage was less than the stoichiometric method. Pretreatment, such as adding CaCl2 or Ca(OH)2, to tie up a major portion of the complexing or to precipitate most of the phosphite improved removal of nickel by either pH adjustment and/or chemical reduction. As expected, the spent EN batch containing lactic acid (EN-1) was easy to treat, even with an initial Ni(II) concentration as high as 18500 mg/l. Both precipitation methods were successful in reducing Ni(II) to < 1 mg/l. Less sodium borohydride would be required with pretreatment by pH adjustment to 7.6 or above. Borohydride treatment was more expensive in chemical cost; however, sludge disposal cost would be lower. Substantial credit may even be realized if nickel precipitate is dissolved in H2SO4 or HCl and then reused in the EN baths. (See also W89-02006) (Lantz-PTT)
W89-02088

NICKEL METAL RECOVERY FROM METAL FINISHING INDUSTRY WASTES,
Recycle Metals, Glastonbury, CT.
C. S. Brooks.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 847-852, 1 fig, 5 tab, 9 ref.

Descriptors: *Nickel, *Metal-finishing wastes, *Industrial wastewater, *Wastewater treatment, Chemical treatment, Copper, Nickel, Zinc, Hydrogen ion concentration, Chemical precipitation, Sulfidation, Feasibility studies.

A flexible separation scheme for efficient recovery of nickel from diverse metal waste systems has been devised, using nickel precipitation augmented by ion exchange. Initial removal of the bulk of copper, iron and zinc contaminants at low pH is conducted by solvent extraction. Removal of the bulk of organic complexing agents and conversion of Cr(3+) to Cr(6+) by autocatalysis augmented by addition of inorganic oxidants (H2O2, NaClO3 or (NH4)2S2O8) enhances the efficiency of the nickel separation. A final sulfidation reduces the residual metals to concentrations compatible with state and EPA standards for water effluents. These bench scale results demonstrate the feasibility of a flexible separation scheme for efficient recovery of nickel from diverse metal waste systems, using

nickel oxalate precipitation augmented by ion exchange. (See also W89-02006) (Lantz-PTT)
W89-02089

TOXICITY STUDIES OF COMBINED METAL FINISHING/MUNICIPAL WASTEWATERS,
Northeastern Univ., Boston, MA. Dept. of Civil Engineering.
F. C. Blanc, J. C. O'Shaughnessy, D. Walker, and S. Miller.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 853-862, 9 fig, 4 tab, 5 ref.

Descriptors: *Toxicity, *Metal-finishing wastes, *Municipal wastewater, *Wastewater treatment, Temperature, Industrial wastewater, Biodegradation, Activated sludge processes, Biological oxygen demand, Chemical oxygen demand, Publicly operated treatment works, Chromium, Suspended solids, Mixed liquor suspended solids, Volatile solids, Biomass.

Four three-liter batch activated sludge reactors were used to evaluate the potential impact of a pretreated metal finishing wastewater on a municipal publicly operated treatment work (POTW). The industrial wastewater used was pretreated effluent from the metal finishing company. The industrial waste use in this study consisted of composite samples collected over the operating day. The domestic wastewaters were grab raw influent samples collected at the POTW. Domestic wastewater samples were kept at 4 C prior to addition to the laboratory treatability units. The industrial wastewaters were kept at 20 C, as wastewater biodegradation was not a problem with the industrial wastewater. From all the data collected in this 8 week treatability study, the industrial wastewater addition did not appear to inhibit the activated sludge reactor performance or produce any detrimental effect on the biological process. The metal finishing wastewater would provide some additional buffering capacity to the municipal metal finishing wastewater mix. There would be no measurable change in effluent BOD concentrations if the combined municipal metal finishing wastewater were treated at the POTW. A slight increase in effluent COD concentration would be possible. The results did indicate that the addition of industrial wastewater would cause additional bioaccumulation of copper in the biological sludge. Data from the shock loading study indicate that spikes of up to 50 mg/l of hexavalent chromium did not affect organic removal performance when assessed 24 hours after dosing. Mixed liquor volatile suspended solids levels suggest that the treated metal plating effluent may have imparted the biomass with resistance to more subtle indications of chromium toxicity. Biomass fluctuations have been used by other authors as indicators of toxicity. (See also W89-02006) (Lantz-PTT)
W89-02090

WASTEWATER MANAGEMENT IN SEMICONDUCTING ELECTRONIC CRYSTAL MANUFACTURING FACILITIES,
Brown and Caldwell, Pleasant Hill, CA.
J. M. Wong.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 863-872, 5 fig, 5 tab, 8 ref.

Descriptors: *Wastewater management, *Wastewater treatment, *Electronics industry, *Industrial wastewater, Chemical wastewater, Costs, Economic aspects, Toxicity, Organic compounds, Arsenic, Fluoride, Suspended solids, Hydrogen ion concentration, Biological oxygen demand, Chemical oxygen demand, Nitrate, Ammonia, Chromium.

Wastewater management is a significant activity in electronic crystal manufacturing plants because of the large amount of chemicals and water required. The source, significance, treatment, and control technology for each pollutant found in electronic crystals manufacturing wastewaters are discussed. These include total toxic organics, arsenic, fluoride, total suspended solids, pH, BOD/COD, nitrate, ammonia, and chromium. In the plant described in the case study, the unit cost of wastewater treatment and disposal was estimated to be $3.20/1000 gallons, which was 3 to 4 times the water purchase cost. Smaller manufacturers would pay even higher unit costs because of the economy of scale. In light of the high cost involved, manufacturers should seek to select the most cost-effective approach by thorough investigation of specific conditions at each plant. (See also W89-02006) (Lantz-PTT)
W89-02091

CONTINUOUS CLOSED LOOP REGENERATION SYSTEM FOR A CHROMIC/SULFURIC ACID ETCHANT BATH,
CH2M Hill, Inc., Portland, OR.
D. J. Kavanaugh, and A. R. Boyce.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 873-882, 6 fig, 5 tab, 15 ref.

Descriptors: *Water reuse, *Recycling, *Wastewater treatment, *Chromic acid, *Sulfuric acid, *Industrial wastewater, Electronics, Costs, Economic aspects, Ions, Feasibility studies.

The feasibility of closed looping a chromic/sulfuric acid etch bath for an electroless plating line was demonstrated. Operating initially in a batch mode with 3 cells on line yielded data regarding the capacity and efficiency of the regeneration system. The decline in $Cr(3+)$ concentration can be evaluated against the 2:1 stoichiometric increase in $CrO3$. The effect of $Cr(3+)$ and $CrO3$ concentration on conversion efficiency is also evident. Conversion efficiency drops sharply when the $Cr(3+)$ concentration dropped below approximately 2 oz/gal (15 g/l). It was observed that after several days of operation in a batch mode that the lead anodes, initially 100%-Pb, dissolved into solution forming a yellow precipitant of lead chromate. This is attributed to the increase in hydrogen ion concentration in the anolyte when operating in a batch mode. When regenerating in continuous mode hydrogen ion increase in the electrolytic cell is balanced by depletion of hydrogen ions in the etch bath. The system has now operated in a continuous model, relatively maintenance free, for 1-1/2 years. The cost for chromic acid is relatively expensive, approximately $1.40/lb. The impetus has been to move away from chromic acid etchants to less effective oxidizers such as permanganate and sulfuric/peroxide. However, close looping a chromic acid etch process by electrolytic regeneration, as presented, makes continued use of chromic acid etchants feasible and economically attractive. (See also W89-02006) (Lantz-PTT)
W89-02092

GM-IX PROCESS: A NOVEL METAL CYANIDE TREATMENT AND RECOVERY TECHNIQUE,
Minnesota Univ., Minneapolis. Dept. of Civil and Mining Engineering.
M. J. Semmens, C. F. Kenfield, R. Qin, and E. L. Cussler.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 883-891, 10 fig, 1 tab, 6 ref.

Descriptors: *Metal-finishing wastes, *Gas membranes, *Ion exchange, *Cyanide, *Wastewater treatment, Zinc, Cadmium, Mass transfer, Chemical treatment, Chemical reactions, Prediction, Model studies.

By interfacing a strongly basic anion exchanger and gas membrane module an effective and efficient means of separating and recovering pure cyanide from dilute cyanide plating wastes has been developed. The process will work effectively for weak metal cyanide complexes such as zinc and cadmium complexes. Preliminary bench scale tests of the Gm-IX process indicate that the process performance may be predicted on the basis of the mass transfer data presented in this paper. (See also W89-02006) (Lantz-PTT)
W89-02093

TWO-STAGE BIOLOGICAL/CHEMICAL TREATMENT OF HAZARDOUS WASTE LANDFILL LEACHATE,
Technische Univ., Brunswick (Germany, F.R.).
H. Albers, and R. Kayser.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 893-906, 12 fig, 5 tab, 12 ref.

Descriptors: *Biological treatment wastewater, *Wastewater treatment, *Chemical treatment, *Hazardous wastes, *Landfills, *Leachates, *West Germany, Cleanup operations, Lime, Water pollution prevention, Biodegradation, Organic matter, Activated sludge process, Chemical oxygen demand, Biological oxygen demand, Nitrification.

Since the 1972 Waste Disposal Act the number of landfills in West Germany has decreased from about 50,000 to 3,118 in 1984. Among these are 385 sanitary landfills and nearly 100 sites for industrial or 'special' wastes. Both types of landfills have to be equipped with a bottom liner and leachate collection system is recommended. The leachates are to be treated before discharge to receiving waters. These leachates contained a great deal of biodegradable organic matter which was removed by activated sludge plants with good efficiency (COD: 80 to 90%, BOD effluents < 25 mg/l). Very low loadings had to be applied. Some problems occurred with poor activated sludge settling characteristics. Biological nitrification of the high ammonical nitrogen contents proved to be a very sensitive process with low reaction rates mainly due to the high salt concentrations and some inhibitory factors. Chemical oxidation with hydrogen peroxide was able to break down parts of the COD still present in the effluents and make them biodegradable, but probably not to such an extent that no further post-treatment steps are needed to meet discharge limiting values. (See also W89-02006) (Lantz-PTT)
W89-02094

MANGANESE TREATMENT BY TWO NOVEL METHODS AT ABANDONED COAL STRIP MINES IN NORTH ALABAMA,
Tennessee Technological Univ., Cookeville. Center for the Management, Utilization and Protection of Water Resources.
J. A. Gordon, and J. L. Burr.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 907-918, 5 tab, 27 ref.

Descriptors: *Biological wastewater treatment, *Manganese, *Wastewater treatment, *Mine wastes, *Alabama, *Oxidation, *Wetlands, Sodium, Potassium, Sulfates, Chemical treatment, Calcium, Magnesium, Iron, Hydrogen ion concentration, Temperature, Sulfur bacteria, Seepage.

The owner/operator of a mining area or reclaimed mine site needed a manganese treatment system that is low in initial cost, requires minimal maintenance, and can operate without electrical power for an indefinite time into the future. Two possibilities for this application are described: manganese oxidation by a packed column system and manganese removal by wetlands. Columns packed with stones from the Duck River below Normandy Dam showed the ability to oxidize and remove dissolved Mn from a seep emanating from a reclaimed strip mine area. The columns were operated in a submerged, upflow manner. The pH of the influent ranged from 5.8 to 6.3 and the temperature ranged from 20 C to 30 C. Effluent concentrations below 2.0 mg/l of Mn were possible at reasonable hydraulic loading rates. The capability of removing soluble Mn was transferred from the Duck River stones to glass marbles and native Alabama sandstone by acclimation procedures. Approximately 8 weeks were needed to produce a good Mn oxidizing slime on the new media. Packed column systems appear to have good potential for treating Mn-laden waters if pH is above 5.5 and Fe

can be removed prior to Mn removal. Wetlands are effective in removing Fe, Mn, Al, Ca, Mg and SO4 as well as increasing pH. Specific conductivity is also decreased by the wetlands system. Al is removed by the limestone berm as Al(OH)3 precipitate. Fe is chemically oxidized by O2 at pH values > 5.5 and the precipitate is removed by the wetlands. Mn is removed by plant uptake and bacteriological oxidation. Ca is removed by marl formation. SO4(2-) is removed by bacterial sulfate reduction to H2S and the H2S is then removed by Beggiatoa sp. and/or photosynthetic sulfur bacteria. Conductivity generally reflect the removal of Fe, Mn, Al, Ca and SO4. Alkalinity increases are caused by the limestone dissolution and CO2 production by bacteria. The pH rises in response to alkalinity increases and the use of protons to form with sulfides to form H2S. (See also W89-02006) (Lantz-PTT)
W89-02095

TREATMENT OF COAL ASH/MINE REFUSE LEACHATE: A CASE HISTORY,
Gilbert/Commonwealth, Inc., Reading, PA.
C. R. Kertell, J. F. Wagner, and S. J. Novotny.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 919-926, 3 fig, 1 tab.

Descriptors: *High density sludge, *Wastewater treatment, *Mine wastes, *Coal mines, *Leachates, Case studies, Conemaugh, Pennsylvania, Hydrogen ion concentration, Lime, Chemical treatment, Sludge, Neutralization.

Large energy production complexes present unique wastewater treatment challenges. The addition of large quantities of mine refuse and coal preparation wastes to the Conemaugh Station coal ash/mine refuse disposal area results in the generation of leachate and runoff with a low pH and significant iron concentration. Although an acceptable effluent can be achieved by the use of conventional lime neutralization, large quantities of sludge are generated which are not readily dewaterable. The High Density Sludge (HDS) process was selected for treatment of the Conemaugh Station ash disposal area leachate and runoff. The HDS process was chosen based upon its ability to greatly reduce sludge volume without the need for a large sludge dewatering operation resulting in reduced sludge disposal costs. This process is a modified lime neutralization process which employs extensive sludge recirculation to produce a dense sludge, containing 20 to 30% solids by weight, from the thickener. (See also W89-02006) (Lantz-PTT)
W89-02096

HEAVY METALS IN WASTEWATER AND SLUDGE TREATMENT PROCESSES. VOLUME II: TREATMENT AND DISPOSAL.
For primary bibliographic entry see Field 5E.
W89-02104

PRIMARY MECHANICAL TREATMENT,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
J. N. Lester.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume II: Treatment and Disposal. CRC Press, Inc., Boca Raton, Florida, 1987. p 1-14, 2 fig, 5 tab, 36 ref.

Descriptors: *Heavy metals, *Wastewater treatment, *Primary wastewater treatment, Sedimentation, Phosphorus removal, Flocculation, Lead, Copper, Zinc, Chromium, Chemical oxygen demand, Suspended solids, Siver, Cobalt, Molybdenum.

The majority of metals entering a sewage works in the raw sewage are concentrated in the sludges, but large quantities of heavy metals may also be discharged to receiving waters in sewage effluents. Primary treatment has traditionally implied a sedimentation process to remove suspended solids by settling under near-quiescent conditions. Sedimentation may not remove all solids, however, due to the minimal settling velocity attributable to either the size or specific gravity of some particles. Colloidal particles are considered to have virtually no settling velocity. Chemicals may be added to remove colloidal solids or for the precipitation of phosphorus compounds during primary settling. Solids removal during primary sedimentation has been correlated with surface-loading rate or overflow velocity, influent solids concentration, and the ratio between sedimentation tank diameter and height. Influent suspended solids concentrations were shown to be more important in controlling solids removal than was the surface loading rate, due to the effect on influent density and degree of flocculation; thus, it was considered that adoption of shorter retention times would not cause a significant loss in removal efficiency. Lead, copper, and zinc were the metals most readily removed by primary sedimentation while nickel was the least readily removed. Chromium was also less readily removed than most metals. The major subfractions present in raw sewage with which heavy metals may be associated are surface-bound organic ligands, insoluble salts and inorganic solids, and soluble organic ligands. A precise chemical characterization of each of these would be impossible to undertake in such a matrix, but gross indications of their distribution may be obtained from measurements of volatile suspended solids (VSS), nonvolatile suspended solids (NVSS), and soluble COD respectively. Silver, cobalt, and molybdenum were strongly associated with the VSS fraction, suggesting that their partition into the solid phase may be primarily due to adsorption or complexation by organic moieties. The second group of metals consisting of Cu, Mn, Pb, and Zn were primarily associated with the NVSS fraction. It was suggested that this may be indicative of their existence in the insoluble fraction of raw sewage. (See also W89-02104) (Lantz-PTT)
W89-02105

BIOLOGICAL TREATMENT,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
J. N. Lester.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume II: Treatment and Disposal. CRC Press, Inc., Boca Raton, Florida, 1987. p 15-40, 3 tab, 152 ref.

Descriptors: *Wastewater treatment, *Biological treatment, *Heavy metals, Removal efficiency, Physical treatment, Chemical treatment, Biodegradation, Activated sludge processes, Volatilization, Flocculation, Sedimentation.

Metal removal during biological treatment has been extensively studied, although the overwhelming majority of results presented are for activated sludge plants (laboratory scale, pilot plant, or full scale). It is reasonable to assume that the adsorption of metals by activated sludge flocs is not dissimilar to the process whereby the biological film in a percolating filter adsorbs metals. An activated sludge system may be divided into two essential parts: a biological reactor and a phase separator. In the reactor or mixed liquor aerator, large populations of microorganisms grown under aerobic conditions oxidize the dissolved or suspended organic compounds present in wastewater and convert them into carbon dioxide, water, and cellular material. The bacteria and other microorganisms form aggregates or flocs. The mixed liquor then passes into the phase separator or settling tank. The flocs separate out by sedimentation from the liquid phase and are returned to the reactor. The supernatant (secondary or final effluent), is then discharged to a watercourse. Any substance which is adsorbed or absorbed by the bacterial flocs is removed from the water passing through a sewage-treatment plant. A combination of flocculation and settling is therefore the mechanism by which metal removal is achieved in the activated sludge process. Any factor affecting the flocculation or settling properties of a mixed liquor - fir example, loading rate, feed composition, mixing strength, sludge volume index (SVI) - will also affect its capacity to remove metals. Removal efficiencies, and factors affecting metal removal are discussed, such as: (1) physical; (2) chemical; (3) mechanisms of metal removal in activated sludge (settlement, binding to polymers, accumulation of soluble metal by the cell, volatilization); and (4) effect of heavy metals on the activated sludge process. (See also W89-02104) (Lantz-PTT)
W89-02106

SLUDGE TREATMENT,
Consultants in Environmental Sciences Ltd., London (England).
T. Rudd.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume II: Treatment and Disposal. CRC Press, Inc., Boca Raton, Florida, 1987. p 41-67, 1 fig, 16 tab, 106 ref.

Descriptors: *Sludge digestion, *Wastewater treatment, *Heavy metals, Economic aspects, Waste disposal, Sludge thickening, Flotation, Anaerobic digestion, Aerobic treatment, Incineration, Sludge disposal.

Wastewater treatment results in a final effluent of a suitable quality for discharge to a watercourse and the production of a number of sludges, many of which require treatment prior to disposal. In the U.K., sewage from 80% of the population is treated in 7795 works, resulting in an annual production of some 30 million tons of wet sludge. The cost of treating and disposing of these sludges is considerable; it has been estimated that it may constitute up to 50% of the entire cost of wastewater treatment, or 200 pounds sterling/annum. Economic constraints thus figure largely in the methods of treatment and disposal adopted. The treatment methods applied to sludge are frequently determined by the final disposal option selected. In cases of direct sea disposal from coastal works, little treatment is necessary. Where the works are situated further inland, however, reductions in sludge volume may be desirable to reduce the cost of transport to locations for both sea and land disposal. On average, approximately 1% of the total flow entering a sewage works is ultimately produced as sludge, and since 50 to 80% of the metals contained in the raw sewage are removed during treatment, there is considerable concentration of metals within the sludge. Accumulation factors (expressed as sludge metal content over influent metal concentrations) have been calculated for metals in waste activated sludge at pilot plant scale. Values of between 7 and 12 were obtained for Ag, Bi, Cd, Cr, Cu, Pb, and Zn, indicating significant accumulation. A similar American study demonstrated that Cr, Cu, Mn, Ni, Pb, and Zn were concentrated over 30 times in primary sludge in comparison to the influent metal concentration. Options which are available for the treatment of sludge include thickening by gravity, stirring, or flotation; aerobic or anaerobic treatment; composting with domestic refuse; inorganic or organic chemical conditioning; dewatering on drying beds, in filter presses, or by vacuum filtration or centrifugation; heat drying; incineration in multiple hearth or fluidized bed furnaces, and wet air oxidation. (See also W89-02104) (Lantz-PTT)
W89-02107

WATER TREATMENT AND REUSE,
Teesside Polytechnic, Middlesbrough (England). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5F.
W89-02108

METHODS FOR RECOVERING VIRUSES FROM THE ENVIRONMENT.
For primary bibliographic entry see Field 5A.
W89-02111

RECOVERING VIRUSES FROM SEWAGE SLUDGES AND FROM SOLIDS IN WATER,
Health Effects Research Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5A.
W89-02113

RECONCENTRATION OF VIRUSES FROM PRIMARY ELUATES,
Baylor Coll. of Medicine, Houston, TX. Dept. of Virology and Epidemiology.

For primary bibliographic entry see Field 5A.
W89-02117

INTEGRATED WASTE MANAGEMENT: AN INDUSTRIAL PERSPECTIVE,
Dow Chemical Co., Midland, MI.
For primary bibliographic entry see Field 5E.
W89-02165

MANAGEMENT OF RESIDUES FROM CENTRALIZED HAZARDOUS WASTE TREATMENT FACILITIES,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W89-02166

PRIMER FOR COMPUTERIZED WASTEWATER APPLICATIONS.
Water Pollution Control Federation, Alexandria, VA. Task Force on Computerized Treatment Plant Application.
Manual of Practice No. SM-5. Water Pollution Control Federation, Alexandria, Virginia. 1986. 123p.

Descriptors: *Wastewater treatment, *Computers, *Wastewater management, *Wastewater facilities, Management planning, Case studies, Wastewater treatment.

When properly applied, computers are tools that increase the productivity and efficiency of a wastewater treatment plant. The manual is a primer for those who want to learn the value of computers, for both management information and process control systems. The purpose of the manual is to discuss what computers are, what they can and cannot do, and how to plan the purchase and start-up of a personal computer or a computer system. Chapter 2 explains how a computer works and describes the basic parts of an operable system. Once one has determined what type of computer is needed for a specific application, Chapter 3 provides general tips on the planning, buying, and start-up of a system. The specification of a system can be based on this information. Numerous case histories are presented in Chapter 4. Cases are given for personal computers, programmable controllers, and large distributed control systems. From this chapter one should be able to see how problems are solved with computers. the actual experience presented in this chapter confirms a wide variety of successful computer applications. To assist the reader, an appendix is provided and a glossary defines most computer terms. The list of suggested references provides the reader with additional sources of information. (Lantz-PTT)
W89-02258

EVALUATION OF GREASE MANAGEMENT ALTERNATIVES FOR ARMY WASTEWATER COLLECTION AND TREATMENT SYSTEMS,
Construction Engineering Research Lab. (Army), Champaign, IL.
J. T. Bandy, R. M. Marlatt, L. E. Lang, C. P. C. Poon, and K. Skov.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A183 743. Price codes: A03 in paper copy, A01 in microfiche. USA-CERL Technical Report N-87/15, May 1987. 44p, 15 tab, 46 ref, 2 append.

Descriptors: *Wastewater treatment, *Grease, *Oil, *Wastewater management, Costs, Biological treatment, Chemical treatment, Case studies, Cost-benefit analysis.

This research was conducted to: (1) determine the nature and extent of grease and oil problems at fixed Army installations, identify the installations' current oil and grease control practices, and evaluate these methods' effectiveness and cost; (2) identify, from published information, commercially available grease and oil control methods (including chemical and biological additives) and establish their properties and applications; (3) collect and evaluate case histories; and (4) provide guidance for determining whether use of an alternative method would be cost-effective at military installations. A survey determined that over two-thirds of the installations responding experienced problems with grease and oil accumulation. Over 80% had problems at least monthly. Army-wide, thousands of dollars are spent each year on grease management. Mechanical cleaning methods are labor-intensive and provide only a short-term solution; chemical cleaners are expensive and can be dangerous to treatment plant workers and the environment. Commercially available biological additives for grease and oil control are identified and described. In addition, case histories are evaluated. Results indicate that the decision to use biological additives in controlling oil and grease accumulation should be made on a case-by-case basis. A procedure is proposed for helping installations calculate grease management costs and determine if use of an alternative technology would be cost-effective. (Author's abstract)
W89-02262

INTERNATIONAL CONFERENCE ON INNOVATIVE BIOLOGICAL TREATMENT OF TOXIC WASTEWATERS.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A183 936. Price codes: A99 in paper copy, A01 in microfiche. June 24-26, 1986, Arlington, Virginia. April 1987. 705p. Edited by R. J. Scholze, Y. C. Wu, E. D. Smith, J. T. Bandy, and J. V. Basilico.

Descriptors: *Toxic wastes, *Wastewater treatment, *Biological treatment, *Hazardous wastes, Toxicity, Kinetics, Model studies, Biodegradation, Heavy metals, Hydrocarbons, Phenols, Biomonitoring, Groundwater pollution.

This conference was conducted to assess the applicability of using biotechnology for the treatment of hazardous toxic wastewaters. The proceedings contain the papers and discussions given by authors and participants. The papers are divided into nine major topic areas: (1) Inhibition kinetics and modeling; (2) Biodegradation of hazardous/toxic wastewaters; (3) Report from the Center for Research in Hazardous and Toxic Substances and the Consortium for Biological Waste Treatment Research and Technology on Hazardous/Toxic Waste Research Projects; (4) Biological removal of phenolic compounds and heavy metals; (5) Research needs workshop; (6) Assessment of integrated wastewater treatment for toxic control; (7) Detoxification of organic hydrocarbons by selective microbes and assessment of bacterial toxicity; (8) Biomonitoring of toxicity in wastewater treatment; and (9) Treatment of contaminated groundwater and leachates. (See also W89-02286 thru W89-02303) (Lantz-PTT)
W89-02267

BIOLOGICAL TREATMENT OF TOXICS IN WASTEWATER: THE PROBLEMS AND OPPORTUNITIES,
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
D. F. Bishop, and N. A. Jaworski.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 2-25, 3 fig, 7 tab, 33 ref.

Descriptors: *Toxic wastes, *Wastewater treatment, *Biological treatment, Toxicity, Waste reduction, Anaerobic digestion, Chemical treatment, Aerobic treatment, Physical treatment, Containment, Costs, Economic aspects, Volatilization, Biodegradation.

The toxicity impact on receiving water ecosystems, bioaccumulative uptake of toxics into the food chain, and effects of toxic discharges in wastewater effluents on the water quality of drinking water are strong factors driving the demand for improved technology for control of toxics. Ongoing EPA research should soon provide the scientific tools to support regulatory action by defining the environmental fate and effects and the health risk of toxics, by identifying the presence of toxics and toxicity in water and wastewater, and by tracing the toxics or toxicity to their sources. For the EPA's regulatory policies on toxic and hazardous wastes to be effective, the Office of Research and Development must identify or develop practical and cost-effective approachs for control of these wastes. These approachs can be conveniently divided into the following general areas: (1) waste reduction through industrial in-plant process modifications, recovery and reuse of toxics; (2) biological treatment (aerobic and anaerobic) including advanced bioengineering concepts; (3) physical-chemical treatment; and (4) waste containment and immobilization. The treatability research aims at evaluating the equilibrium and kinetics relations of the principal removal mechanism in conventional primary-secondary (biological) treatment. The important mechanisms are: (1) partitioning (sorption) on solids and biomass; (2) volatilization (air stripping and surface desorption); and (3) biodegradation (aerobic and anaerobic). The goals of the research include developing appropriate bench-scale treatability protocols for experimentally determining the fate of specific toxics in and their impact on the conventional primary-secondary treatment system; determining kinetic and equilibrium data on representative toxics for the principal treatment mechanism; and, using the experimental data, developing predictive models for estimating the fate of toxics in conventional treatment from the chemical properties and structural activity relations of the individual toxics. (See also W89-02267) (Lantz-PTT)
W89-02268

HAZARDOUS WASTE MANAGEMENT: BIOLOGICAL TREATMENT,
National Solid Wastes Management Association, Washington, DC.
S. W. Pirages.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 26-36.

Descriptors: *Toxic wastes, *Waste management, *Hazardous wastes, *Wastewater treatment, *Biological treatment, Management planning, Regulations, Industrial wastes, Monitoring.

A waste service industry has emerged in response to the national concern for management of hazardous waste. The current members in the commercial service industry became involved in hazardous waste management activities only in response to the 1976 Resource Conservation and Recovery Act (RCRA). This commercial waste service industry recognizes the potential application of biological treatment for industrial hazardous wastes. Facilities employing this technique currently exist in Canada and the United States. Greater application and commercial development is possible, particularly if certain operational/performance criteria are met. These include: (1) complete destruction of hazardous constituents; (2) the ability to concentrate target constituents for further treatment or for resource recovery; (3) application of the technology to a diverse range of hazardous constituents found in mixtures, rather than in single constituent waste streams; and (4) consistency among treatment batches to reduce the need for expensive monitoring of the residue, and of the ability to be competitive financially with other treatment technologies that are currently available. (See also W89-02267) (Lantz-PTT)
W89-02269

TOXICITY ASSAYS AND MOLECULAR STRUCTURE TOXICITY,
Drexel Univ., Philadelphia, PA.
R. E. Speece, N. Nirmalakhandan, and P. C. Jurs.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 37-64, 9 fig, 4 tab, 46 ref.

Descriptors: *Toxic wastes, *Toxicology, *Wastewater treatment, *Toxicity, *Molecular structure, *Bioassays, Chemical analysis, Biological studies, Model studies, Mathematical studies, Chemical properties, Water pollution effects.

When one considers the complexity of a biological system's response to toxic chemicals, it would appear to be overly optimistic to attempt to formulate a rational quantitative - structure activity relationship (QSAR) based upon molecular structure or gross properties. The concept that a relation exists between the structure of a molecule and its biological activity was formulated in 1868. One of the greatest problems in QSAR studies is the translation of molecular structure into simple and unique numerical descriptors. These descriptors should be parameters of such fundamental properties of a molecule which determine possibly the biological activity and toxicity. Various parameters have been used in QSAR studies such as the Hansch constant, hydrophobic fragmental constant, partition coefficient in octanol/water, molvolume, surface activity, molar refraction, polarizability of electrons, Taft constant, Hammett factor, parachlor and molecular connectivity indices. QSARs do not indicate much about the kind of action of the compounds. However, when a high quality QSAR is found for a group of compounds, it might indicate that the action is similar. If the temptation to extrapolate QSAR models beyond the bounds in which they were derived can be resisted, then some very useful ecotoxicological predictive models can be used as 'screening tools' to 'flag' chemicals which may warrant more extensive testing. Likewise, if the idiosyncrasies of the various bacterial toxicity assays can be appropriately factored in, much qualitative information can be gleaned for various environmental purposes. (See also W89-02267) (Lantz-PTT)
W89-02270

COMPETITIVE KINETIC MODEL OF SUSPENDED-GROWTH INHIBITED BIOLOGICAL SYSTEMS,

Pontificia Univ. Catolica de Chile, Santiago. Dept. of Hydraulic Engineering.
P. B. Saez.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 65-79, 9 fig, 17 ref. National Commission of Scientific and Technological Research Grant 0126/85.

Descriptors: *Wastewater treatment, *Toxic wastes, *Kinetics, *Biological studies, *Model studies, Growth kinetics, Mathematical models, Mathematical studies, Toxicity, Biodegradation.

A kinetic model of suspended-growth inhibited biological systems is based upon fundamental principles, which include mass balances and kinetics relationships. It is supposed that the inhibitor may be biodegradable, following a Monod function. Another assumption is that the substrate utilization rate is given by the general theory of competitive reversible inhibition, and completely determine the cell's growth rate. The model has been normalized to better understand the process. the response of the model with changes in the influent substrate and inhibitor concentrations is also discussed. The main contribution of the model presented is that it helps in the identification of research needs in kinetic modeling of inhibited systems. First, it is clear that more experimental results are required. Second, the model has been structured to visualize its assumptions, which can be changed in order to find those that better represent the real world. For example, it is possible to construct models in which the inhibitor utilization rate follow an Haldane function, or the substrate utilization rate could be modeled by uncompetitive or noncompetitive reversible inhibition, or the active bacterial growth also depend on the inhibitor utilization rate, etc. The model may be easily applied to batch or plug-flow suspended-growth reactors. The only changes are related to mass balance equations. Also, its principles could be used to model inhibited biofilm reactors. (See also W89-02267) (Lantz-PTT)
W89-02271

TOXICITY OF NICKEL IN METHANE FERMENTATION SYSTEMS: FATE AND EFFECT ON PROCESS KINETICS,

Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
S. K. Bhattacharya, and G. F. Parkin.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 80-99, 7 fig, 7 tab, 21 ref.

Descriptors: *Wastewater treatment, *Toxic wastes, *Toxicity, *Nickel, *Fermentation, Kinetics, Acetate, Heavy metals, Propionate, Model studies, Chemical analysis.

The objectives of this research was to study to study the kinetic effects of nickel on anaerobic utilization of acetate and propionate and to determine its fate in these systems. Nickel was added both as slug and continuous doses. With the shock of a slug addition, there should be minimal chance for acclimation to nickel by the bacteria. With continuous addition, however, the concentration of nickel can be increased gradually and the bacteria will have a chance to acclimate. The following conclusions are drawn from this study: (1) Acetate-utilizing methanogens are more severely affected than propionate utilizers by nickel; (2) Massive slug doses of nickel immediately stop bacterial activity. Smaller slug doses give lower-HRT systems a better chance to recover; (3) Response to nickel toxicity is similar to uncompetitive inhibition. The Uncompetitive-Inhibition-Coefficient model worked well for continuous addition of nickel; (4) The Uncompetitive-Inhibition-Coefficient model did not adequately describe the fate of systems exposed to slug doses of nickel; and (5) Without acclimation to nickel, total soluble nickel concentrations above 6 mg/L caused failure. Total soluble nickel concentrations as high as 31 mg/L could be tolerated with acclimation. (See also W89-02267) (Lantz-PTT)
W89-02272

HEAVY METAL REMOVAL BY AQUATIC MACROPHYTES IN A TEMPERATE CLIMATE AQUATIC TREATMENT SYSTEM,

New Hampshire Univ., Durham. Dept. of Civil Engineering.
P. L. Bishop, and J. DeWaters.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 100-117, 5 tab, 11 ref. NSF Grant CEE-8209851.

Descriptors: *Toxic wastes, *Wastewater treatment, *Heavy metals, *Macrophytes, *Temperate zone, *Aquatic plants, Biological treatment, Filtration, Adsorption, Oxygen, Copper, Lead, Nickel, Cadmium, Zinc.

The aquatic macrophytes play an essential role in aquatic treatment systems. The roots, stems and leaves of the plants in the water column provide a surface on which bacteria can grow and provide a media for filtration and adsorption of solids. They also provide oxygen to the bacteria through photosynthesis. The stems and leaves at or above the water surface help to attenuate sunlight and thus prevent growth of suspended algae, and reduce effects of wind on the water, thus minimizing roiling of sediments. In essence, aquatic treatment systems are similar to horizontal flow trickling filters in which macrophytes replace the trickling filter media as a support structure for bacteria. The plants play the additional role of nutrient and heavy metal assimilators. These studies, performed under both warm and cold weather conditions using three different temperate climate aquatic macrophytes, suggest that the heavy metal removal efficiencies of various aquatic macrophyte treatment systems varies depending on the metal considered, but that the underlying removal mechanisms are probably the same. In essentially all cases, metal removal sin the macrophyte-containing reactors were better than in the control reactors. Much of this additional removal is probably due to the epifloral biofilms growing on the macrophytes rather than to the macrophytes themselves. This is potentially very beneficial to the plants as it prevents high concentrations of toxic heavy metals from bioconcentrating in the macrophyte's tissues. Copper was almost entirely removed from the waste stream in aquatic treatment systems containing the temperate climate macrophytes Elodea nuttallii and Myriophyllum heterophyllum; substantial quantities of lead and zinc were also removed. Removal rates for cadmium and nickel were much lower, but this may have been due to the low concentrations present in the raw wastewater. (See also W89-02267) (Lantz-PTT)
W89-02273

REMOVAL OF HEAVY METAL BY RECYCLING OF WASTE SLUDGE IN THE ACTIVATED SLUDGE PROCESS,

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K. L. Tsai, and P. S. Cheung.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 118-135, 6 fig, 6 tab, 4 ref. National Science Council of the Republic of China Project NSC 75-0410-E035-01.

Descriptors: *Toxic wastes, *Heavy metals, *Recycling, *Wastewater treatment, *Activated sludge process, Sludge, Adsorption, Sedimentation, Chemical oxygen demand.

In the conventional activated sludge process, part of the settled sludge from the final clarifier is returned to the aeration tank and the rest of is wasted. It has been known for a long time that activated sludge has very strong adsorptive power. In this study waste sludge is first recycled to the incoming sewage such that it could adsorb the heavy metals and part of the organic matter. Metals are then removed in the primary settling tank. This could simultaneously protect the biological unit from excess incoming toxic heavy metal ions and also reduce the organic load to the aeration tank; thus considerable energy could be saved. Jar tests were used to investigate the feasibility of this application. Results indicated that activated sludge has good adsorption ability. As compared to plain sedimentation, with added activated sludge, additional COD removal ranged from 11-52% and that for heavy metal varied from 15-32%. (See also W89-02267) (Author's abstract)
W89-02274

EFFECT OF INORGANIC CATIONS ON BIOLOGICAL FIXED-FILM SYSTEMS,

Purdue Univ., Lafayette, IN. School of Civil Engineering.
R. W. Peters.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 136-157, 2 fig, 2 tab, 46 ref.

Descriptors: *Toxic wastes, *Wastewater treatment, *Inorganic compounds, *Biological treatment, *Cations, Heavy metals, Trickling filters, Anaerobic digestion, Adsorption, Biological filters, Enzymes.

The effects and inhibitions associated with heavy metals on the performance of fixed-film biological processes such as trickling filters, anaerobic filters, and rotating biological contactors, have been addressed. High concentrations of heavy metals are toxic to most microorganisms. The degree of metal inhibition varies with different biological species. Toxicity generally takes the form of enzyme inhibition. Heavy metals may adversely affect microbial metabolism by inhibiting enzyme catalysis. Metals can bind at the enzyme-active sites or cause conformational changes in the enzyme. Although numerous studies have been performed on the inhibitory effect of heavy metals on various microorganisms, the results are difficult to compare for a variety of reasons. With proper acclimation, the biological system can be used to remove a certain amount of the metal(s) without being adversely affected. The due to sorption of both soluble and fine particulates by the biofilm. The anaerobic filter is quite efficient for removal of heavy metals and retention of the metals in the biofilm. Due to the relatively recent development of fixed-film processes, much less attention has been paid to these processes (as compared to suspended growth systems) particularly in terms of heavy metal inhibition. (See also W89-02267) (Lantz-PTT)
W89-02275

PHYSICAL-CHEMICAL AND ANAEROBIC FIXED FILM TREATMENT OF LANDFILL LEACHATE,
Technical Univ. of Nova Scotia, Halifax. Dept. of Civil Engineering.
D. Thirumurthi, S. M. Rana, and T. P. Austin.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 158-195, 13 fig, 16 tab, 16 ref.

Descriptors: *Toxic wastes, *Wastewater treatment, *Chemical treatment, *Anaerobic digestion, *Landfills, *Leachates, *Water pollution prevention, Heavy metals, Aluminum, Chromium, Iron, Manganese, Nickel, Vanadium, Zinc, Hydrogen ion concentration, Alum, Sludge, Sodium carbonate, Chemical oxygen demand, Biomass.

The following conclusions can be made, based on this laboratory-model study: (1) The single most important factor that overwhelmingly governs the precipitation of metals such as Al, Cr, Fe, Mn, Ni, V and Zn from the leachate is pH; (2) Low doses of alum and FeCl3 (up to 40 mg/L in each case) have very little effect on metals removal; (3) Though alum at 80 mg/L and FeCl3 at 200 mg/L enhanced the precipitation of the metals, the expected higher costs associated with the chemicals and the disposal of excess sludge produced prohibit the use of the chemicals; (4) The volume of settled sludge increased as the flocculation pH increased; (5) At a given pH, lime slurry was slightly more efficient than KOH in precipitating the metals; (6) Sodium carbonate, even at a high dose of 4000 mg/L, was not effective in removing the metals; (7) Subsequent to physical-chemical treatment and phosphate supplementation, the leachate was successfully treated biologically; (8) The upflow anaerobic fixed film reactor (AFFR) with modular blocks, at an organic load of 1.6 kg/d/cu m and at 32 + or - 2 C, reduced the COD of the pretreated leachate from 21,800 to 780 mg/L, TOC from 7680 to 200 mg/L, VSS from 237 to 24 mg/L and SS from 756 to 36 mg/L; (9) When the biomass within the reactor was estimated on the last day of the experiment, it was concluded that 77% of the biomass (VSS) was in the liquid phase of the reactor held in the interspaces of the medium while the balance was on the biofilm of the solid medium; (10) The substrate removal rate was estimated to be 1.77 g of COD/d/g of VSS in the liquid phase of the reactor; and (11) A precise value of the substrate removal rate can be calculated only when a precise definition of the biomass can be standardized. (See also W89-02267) (Lantz-PTT)
W89-02276

TREATMENT OF LEACHATE FROM A HAZARDOUS WASTE LANDFILL SITE USING A TWO-STAGE ANAEROBIC FILTER,
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
Y. C. Wu, O. J. Hao, and K. C. Ou.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 196-220, 6 fig, 6 tab, 41 ref. Army Construction Engineering Research Lab. Grant DACA 888 EC 0013.

Descriptors: *Toxic wastes, *Wastewater treatment, *Leachates, *Water pollution prevention, *Hazardous wastes, *Landfills, *Anaerobic digestion, Filtration, Organic matter, Metals, Chemical oxygen demand, Biological oxygen demand, Volatile acids, Biological treatment, Biofiltration, Ammonia, Nitrogen.

Leachate from a hazardous waste landfill site contained a high concentration of organic matter and low metal concentrations. COD, BOD and volatile acid were approximately 21, 14, and 1.9 g/L, respectively. Both the strength and chemical composition of raw leachate varied with sampling time. The high ratio of BOD to COD of raw leachate is amenable to biological treatment. The start-up of the anaerobic filter system was highly time-consuming. Larger quantities of seed material and higher temperatures should reduce the start-up time. With an organic loading up to 4 g COD/d/sq m, COD/BOD removal was satisfactory, even though the leachate contained several toxic pollutants. BOD as low as 130 mg/L or a 98% reduction could be achieved. The biofilters were very effective for metal removal. However, the anaerobic process did not remove ammonia and the effluent NH3-N concentration often increased due to degradation of nitrogenous organic matter. Either chemical process or biological nitrification may be employed to remove residual BOD and ammonia to an acceptable level. (See also W89-02267) (Lantz-PTT)
W89-02277

EFFECTS OF EXTENDED IDLE PERIODS ON HAZARDOUS WASTE BIOTREATMENT,
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
A. S. Weber, M. R. Matsumoto, J. G. Goeddertz, and A. J. Rabideau.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 221-243, 8 fig, 4 tab, 6 ref.

Descriptors: *Toxic wastes, *Water pollution treatment, *Hazardous wastes, *Biological treatment, *Biodegradation, Costs, Leachates, Groundwater pollution, Chemical oxygen demand, Temperature, Activated carbon, Landfills.

An experimental study was conducted to assess the technical feasibility of biological processes treating hazardous waste when extended periods of inoperation are imposed on operation protocol. The impetus for this study was to develop a process that could provide cost effective treatment of leachate and contaminated groundwater from a former hazardous waste handling facility in upstate New York. Waste collection rates at the site are expected to be low and as such, intermittent process operation will be desirable or necessary. Based on the reported findings of the experimental study, intermittent biological treatment can achieve significant removal of waste pollutants. In this study the rate of COD removal was adversely affected by decreases in operation frequency and decreased operating temperatures. However, if reaction periods are extended, all biodegradable COD removal can be removed in bioreactors using long lag periods. Addition of powdered activated carbon was tested under one operating scenario and hypothesized to be advantageous in reducing aeration times for conditions of low temperature and extended lag periods. While the feasibility of intermittent biological treatment was studied using a groundwater contaminated with hazardous waste substances, other potential applications exist. They include; leachate treatment of municipal and hazardous waste landfills, industrial waste flows released on an intermittent basis, and other waste sites requiring remediation. (See also W89-02267) (Lantz-PTT)
W89-02278

TECHNIQUE TO DETERMINE INHIBITION IN THE ACTIVATED SLUDGE PROCESS USING A FED-BATCH REACTOR,
Vanderbilt Univ., Nashville, TN. Dept. of Civil and Environmental Engineering.
A. T. Watkin, and W. W. Eckenfelder.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 244-259, 4 fig, 3 tab, 10 ref.

Descriptors: *Toxic wastes, *Pesticides, *Wastewater treatment, *Activated sludge process, Model studies, Dichlorophenol, Organic compounds, Glucose, Kinetics, Statistical studies.

Modeling of activated sludge systems' response to unsteady state inputs of a known inhibitory compound is the primary focus of this paper. Glucose and 2,4-dichlorophenol (DCP) acclimated sludges will be used in assessing unsteady-state inhibition kinetics of DCP on glucose removal. The unsteady-state inhibitory and non-inhibitory responses of DCP and glucose is modeled in a specific semi-batch reactor configuration known as a fed-batch reactor. Distinctly, different inhibition constants were for three sludges with different histories. These differences were shown to be statistically significant by Tukey's Method at a global significance level of 5%. A sludge acclimated to DCP and glucose demonstrated a mean inhibition constant (K sub I) value of 17.3 mg/L. This value was significantly higher than for sludge which was previous but not currently acclimated to DCP, demonstrating an inhibition constant of 6.5 mg/L. A third sludge which like the others was acclimated to glucose, but which had never been acclimated to DCP demonstrated the highest mean K sub I value of 40.4 mg/L. From these results it is apparent that there is no universal inhibition constant for DCP on glucose removal. The inhibition constant for DCP is likely to be highly dependent on the specific enzyme system involved, which in turn is dependent on the history and population dynamics of the sludge. Several aerobic pathways for glucose metabolism have been demonstrated. The inhibition constant, K sub I may be highly dependent on which metabolic pathway(s) is (are) present in any given mixed microbial population such as those studied in this work. (See also W89-02267) (Lantz-PTT)
W89-02279

COMPARISON OF THE MICROBIAL RESPONSE OF MIXED LIQUORS FROM DIFFERENT TREATMENT PLANTS TO INDUSTRIAL ORGANIC CHEMICALS,
New Jersey Inst. of Tech., Newark. Dept. of Chemical Engineering.
G. Lewandowski, D. Adamowitz, P. Boyle, L. Gneiding, and K. Kim.
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Descriptors: *Toxic wastes, *Wastewater treatment, *Microbiological studies, *Industrial wastewater, *Organic compounds, *Detoxification, Case studies, Municipal wastewater, Biological oxygen demand, Phenols, Chlorophenol, Dichlorophenol, Dichlorophenoxyacetic acid, Public owned treatment works.

As the first stage of an effort to determine the ability of publicly owned treatment works (POTWs) to detoxify industrial organic chemicals, several compounds were added individually to the mixed liquors from two very different treatment plants - the Livingstone (NJ) municipal wastewater treatment, plant, and the Passaic Valley Sewerage Commissioners (PVSC) plant in Newark (NJ). The former handles 2.5 million gallons/d of domestic sewage, while the latter handles 250 MGD of wastewater with a 55% industrial component (on a BOD basis). An aerated batch reactor was used, and the chemicals (and feed concentrations) were: phenol (100 ppm), 2-chlorophenol (20 ppm), 2.6-dichlorophenol (10 ppm), and 2,4-dichlorophenoxyacetic acid (10 ppm). Substrate disappearance was determined by gas chromatography, and the microbial systems characterized by microscopy and plating techniques. Although the two mixed liquors came from very different systems, their response to the industrial chemicals added, as well as the initial and final microbial populations, were very similar. This suggests that the phenomena observed might be generalized to many other POTWs. (See also W89-02267) (Lantz-PTT)
W89-02280

SBR TREATMENT OF HAZARDOUS WASTEWATER - FULL-SCALE RESULTS,
Jet Tech, Inc., Industrial Airport, KS.
K. L. Norcross, R. L. Irvine, and P. A. Herzbrun.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 275-294, 7 fig, 3 tab, 10 ref.

Descriptors: *Toxic wastes, *Hazardous wastes, *Wastewater treatment, *Biological treatment, Temperature, Oxygen, Dissolved solids, Suspended solids, Aeration, Heavy metals.

A preliminary pilot study was completed to evaluate the possibility of utilizing the sequencing batch

biological reactor (SBR) process to pretreat landfill leachate and hazardous waste streams prior to polishing with the existing activated carbon system. The motivation for the study was a desire to reduce carbon regeneration energy and make-up costs. The results of the pilot study were successful and a full-scale, 550,000 gallon SBR reactor was designed and installed in the winter of 1983/84 in Niagara Falls, NY. Qualitative parameters associated with oxygen transfer (alpha, beta) were evaluated during the pilot study. The data indicated that alpha increased with increasing aeration turbulence and shear rate. Process performance was shown to be highly temperature sensitive, decreasing rapidly at low temperatures. A submerged jet aeration system was selected for high efficiency, high heat conservation, independent aeration and mixing, and alpha resistance. After one year of operation, the plant has proven to be stable and effective. The system maintained a mixed liquor temperature 10 c above the influent temperature. Oxygen transfer alpha values were measured to range between 0.75 and 2.0, while beta values ranged from 0.6 to 0.75 (TDS was 30,000 mg/L). The system operated at roughly half the design power requirements. The system maintained stability throughout the entire year except for two heavy metal toxicity strikes which decreased treatment efficiency for several days. The effluent decanting system and rapid settleability of the mixed liquor resulted in minimum effluent suspended solids values. As a result of the organic and phenol removal efficiencies achieved by the SBR, carbon changes were reduced by about 50%. Annual carbon cost savings are estimated to be $200,000/yr. (See also W89-02267) (Author's abstract)
W89-02281

USE OF PURE CULTURES AS A MEANS OF UNDERSTANDING THE PERFORMANCE OF MIXED CULTURES IN BIODEGRADATION OF PHENOLICS,
New Jersey Inst. of Tech., Newark. Dept. of Chemical Engineering.
G. Lewandowski, B. Baltzis, and C. P. Varuntanya.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 295-318, 17 fig, 10 ref.

Descriptors: *Toxic wastes, *Wastewater treatment, *Biodegradation, *Phenols, *Microbiological studies, Bacteria, Biological treatment, Kinetics, Model studies, Biomass.

Eleven dominant bacterial species were isolated from a phenol-acclimated mixed liquor obtained originally from the Passaic Valley Sewerage Commissioners wastewater treatment plant in Newark, NY. However, of these eleven species, only three (Klebsiella pneumoniae, Serratio liquefaciens, and Pseudomonas putida) were able to degrade phenol. Therefore, the remaining eight species must have survived by utilizing the metabolic products of the three primary phenol degraders. Regarding the three primary phenol degraders, when the same species were purchased from commercial suppliers, they could not degrade phenol, which underlines the importance of the strain as well as the species. Using the kinetic parameters from the single species experiments, a simple competitive model was tested for phenol utilization by any two of the three primary phenol degraders. This model was able to predict the rate of total biomass growth fairly well, but was much less accurate in predicting the rate of substrate utilization. This indicates that simple competition for the same substrate is not an adequate physical model for the mixed culture system. It may be, for example, that one (or both) of the organisms is producing an inhibitory agent for the growth of the competing organisms. (See also W89-02267) (Lantz-PTT)
W89-02282

COMPARTMENTALIZED ONE SLUDGE BIOREACTOR FOR SIMULTANEOUS REMOVAL OF PHENOL, THIOCYANATE, AND AMMONIA,
Florida International Univ., Miami. Dept. of Civil and Environmental Engineering.
J. H. Greenfield, and R. D. Neufeld.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 319-331, 1 fig, 1 tab, 12 ref.

Descriptors: *Wastewater treatment, *Sludge, *Biological treatment, *Toxic wastes, *Phenols, *Thiocyanate, *Ammonia, Aeration, Sludge digestion, Biodegradation, Settling.

Of the processes available for the removal of ammonia from steel industry wastewaters, engineered biological systems are the most pragmatic. Data from the steel industry indicate that a properly designed and operated biological nitrification facility is capable of reducing ammonia levels to < 10 mg/L over extended periods of time. Biological nitrification processes, however, are known to exhibit unaccounted for upsets, and thus are considered in some industrial sectors as unreliable. Four rectangular Plexiglas aeration tanks were constructed for this research. The aeration basins had a working volume of 20 L. All four bioreactors were operated under similar conditions. First, the mixed cultures were fed ammonium chloride to establish nitrification. When this was established, reagent phenol effluent was analyzed, thiocyanate was added to the feed. In order to meet the objectives, the bioreactors were designed to be 1,2,3, and 4 compartment bioreactors. The one compartment bioreactor displayed 99% removal efficiencies for phenol, thiocyanate, and ammonia when the influent concentrations for all three substrates was approximately 150 mg/L and when the reactor was operated at an actual sludge age of 43 days. The two compartment bioreactor displayed > 99% removal efficiencies for thiocyanate, phenol, and ammonia when the reactor consisted of SCN(-) = 350 mg/L, phenol = 300 mg/L, and NH3 = 200 mg/L at an actual sludge age of 42 days. Experimental results from the three and four compartment reactors at sludge ages of 63 and 57 days respectively, exhibited similar effluent phenol and ammonia concentrations. The steady-state results from the 1-4 compartment reactors displayed > 90% removal of all three substrates in the first compartment with the remaining compartments functioning as final polishing tanks. By utilizing compartmentalized reactors, the working volume of the aeration basin can be reduced by as much as one half without a loss in efficiency. (See also W89-02267) (Lantz-PTT)
W89-02283

HIGH-RATE BIOLOGICAL PROCESS FOR TREATMENT OF PHENOLIC WASTES,
Delaware Univ., Newark. Dept. of Civil Engineering.
A. F. Rozich, R. J. Colvin, and A. F. Gaudy.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 332-361, 7 fig, 1 tab, 22 ref, append.

Descriptors: *Toxic wastes, *Wastewater treatment, *Biological treatment, *Phenols, *Fluidized bed process, Biodegradation, Aeration, Sludge, High flow.

A proposed process flow scheme for a high-rate fluidized biological system for treating phenol wastes was presented. The key feature of this system is the use of two reactors each of which has different operating conditions. The first stage of the system is utilized for selective culture of organisms which are characterized by high-rate phenol degradation kinetics; the critical parameter for selecting these populations appears to be the maintenance of relatively high (> or= 100 mg/L) steady-state phenol concentrations in this reactor. The second stage of the system is operated in an extended aeration mode (extremely low growth rates) in order to achieve low effluent organic concentrations. The advantages of this process over conventional technology are significantly increased phenol degradation rates and lower sludge production rates; the results of the bench-scale pilot study indicate that the process may also be capable of delivering lower phenol concentrations than can a conventional single-stage technology. Equations were also derived which may be utilized, subsequent to additional developmental work on the process, for providing guidelines for design and operation. Finally, it is pointed out that application of the high-rate process technology is not contingent on the design of new facilities. (See also W89-02267) (Lantz-PTT)
W89-02284

BIOTECHNOLOGY FOR THE TREATMENT OF HAZARDOUS WASTE CONTAMINATED SOILS AND RESIDUES,
Cook Coll., New Brunswick, NJ. Dept. of Biological and Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W89-02285

BIOLOGICAL DEGRADATION OF POLYCHLORINATED BIPHENYLS,
General Electric Corporate Research and Development, Schenectady, NY. Biological Sciences Branch.
For primary bibliographic entry see Field 5G.
W89-02286

5E. Ultimate Disposal Of Wastes

EFFECTS OF OIL REFINERY EFFLUENTS ON SELENASTRUM CAPRICORNUTUM PRINTZ,
Udai Pratap Coll., Varanasi (India).Dept. of Botany.
For primary bibliographic entry see Field 5C.
W89-01272

MARKETING SLUDGE COMPOST IN JAPAN,
Japan Sewage Works Agency, Toda. Research and Technology Development Div.
T. Matsui, S. Chida, T. Ishida, and H. Ishii.
Biocycle BCYCDK, Vol. 29, No. 6, p 36-42, July 1988. 10 tab.

Descriptors: *Sludge utilization, *Fertilizer, *Compost, *Marketing, Japan, Farming, Case studies, Pricing, Prediction.

In recent years, interest has been growing in the use of organic fertilizer to recoup the fertility of soil which has been seriously strained and wasted by chemical-intensive farming; this in turn is building the demand for sewage sludge as an organic fertilizer. The state-of-the-art on composting facilities in Japan and the marketing competition of sludge compost with chemical fertilizers are discussed and a case studies are presented of marketing trends in four areas of Japan differing in climate and farming structure. A reference price for a 20 kg bag of sewage sludge compost is forecast to be about Y500. Considering the current prices, the upper limit seems to be Y700/20 kg. Sludge prices should be set after due consideration of the prices of locally distributed competing fertilizers. Sludge compost is expected to be sold mainly in bags as it is now. However, sales by measure or weight should also be practiced to meet the needs of large users. Sludge compost should be available in diversified forms; it can be pelletized to meet mechanized farming, or can be enriched with additives for differentiation from competing fertilizers. (Sand-PTT)
W89-01294

SOLUBILITY RELATIONSHIPS OF ALUMINUM AND IRON MINERALS ASSOCIATED WITH ACID MINE DRAINAGE,
University of Wyoming Research Corp., Laramie. Western Research Inst.
For primary bibliographic entry see Field 5G.
W89-01322

DESIGN AND PERFORMANCE OF A LARGE DISPOSAL FIELD (CONCEPTION ET PERFORMANCE D'UN CHAMP D'EPANDAGE DE GRANDES DIMENSIONS),
Ecole Polytechnique, Montreal (Quebec). Dept. de Genie Mineral.
R. P. Chapuis.
Canadian Journal of Civil Engineering CJCEB8,

Vol. 15, No. 2, p 216-222, April 1988. 9 fig, 19 ref. English summary.

Descriptors: *Wastewater disposal pollution, *Soil disposal fields, *Land disposal, *Groundwater, Piezometers, Infiltration rate, Exfiltration rate.

A large wastewater disposal field (31 x 69 m) was designed in agreement with legal recommendations. A full scale test with clear water revealed that the field exfiltration rate was much lower than anticipated. The design, the instrumentation performed with 11 piezometers, the groundwater conditions as modified by the disposal field, how the true exfiltration rates were determined after due consideration of natural precipitations and evaporation losses, and the method used to improve the performance are performed. The value of the infiltration rate into the soil, initially established by percolation tests, was confirmed by permeability tests performed in the piezometers. However, the true exfiltration rate of this disposal field was only 8% of the rate predicted by the conventional, legal design. This exfiltration rate cannot be derived by simple transposition of the results of percolation tests as presently done by regulations. Alternatively, more rigorous methods are described. For a good design, it is necessary to perform hydrogeologic studies much more detailed than those presently required by regulations. For improving the design and service life of such disposal fields, several suggestions are made to avoid water mounds and to reduce the risk of clogging. (Author's abstract)
W89-01338

EFFECTS OF COMMERCIAL LANDFILL BANS ON WASTE MINIMIZATION STRATEGIES AND TREATMENT PERFORMANCE STANDARDS,
RECRA Environmental, Inc., Amherst, NY.
T. F. Stanczyk.
Environmental Progress ENVPDI, Vol. 7, No. 3, p 151-154, August 1988. 4 fig, 17 ref.

Descriptors: *Waste management, *Solid waste disposal, *Landfills, Leachates, Metals, Solubility, Legislation, Enforcement, Regulation.

Industries and governmental agencies throughout the U.S. are confronted with a number of issues focusing on the subject of what is, and how, hazardous and contaminated solid waste should be properly managed and controlled. Waste acceptance criteria governing landfill receipts include several limitations and restrictions on waste constituents. Restrictions concerning free liquid, metal solubility, reactivity, halogenated organic compounds, volatile organics, and leachability are discussed. To meet future requirements, several strategies can be developed that have application to waste minimization and improved treatment performance. Such strategies are briefly outlined for wastewater treatment, sludge reduction and stabilization, solid residues laden with volatile solvents, and organic residues. (Sand-PTT)
W89-01341

GEOSYNTHETICS: CLEANUP TOOLS,
Soil and Material Engineers, Inc., Raleigh, NC.
For primary bibliographic entry see Field 8G.
W89-01346

PROCEDURE FOR MANAGING CONTAMINATED DREDGED MATERIAL,
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-01358

MANAGING CONTAMINATED DREDGED MATERIAL: APPLICATION,
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-01359

TREATMENT OF LANDFILL LEACHATES IN ON-SITE AERATED LAGOON PLANTS: EXPERIENCE IN BRITAIN AND IRELAND,
Aspinwall and Co., Shrewsbury (England).
For primary bibliographic entry see Field 5D.
W89-01451

LAND FARMING OF RESERVE PIT FLUIDS AND SLUDGES: FATES OF SELECTED CONTAMINANTS,
Oklahoma State Univ., Stillwater.
For primary bibliographic entry see Field 5B.
W89-01460

SLUDGE TREATMENT, UTILIZATION, AND DISPOSAL,
Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.
For primary bibliographic entry see Field 5D.
W89-01474

LAND APPLICATION OF WASTEWATER,
ERM-Southeast, Inc., Marietta, GA.
For primary bibliographic entry see Field 5D.
W89-01479

FRUIT, GRAIN, AND VEGETABLE WASTES,
Brigham Young Univ., Provo, UT. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-01483

RADIOACTIVE WASTES,
New Mexico Univ., Albuquerque. Dept. of Civil Engineering.
B. M. Thomson.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 916-920, June 1988. 75 ref.

Descriptors: *Literature review, *Radioactive wastes, *Radioactive waste disposal, *Nuclear powerplants, *Water pollution control, Path of pollutants, Fate of pollutants, Waste dumps, Remedies, Wastewater treatment, Fuel reprocessing, Waste disposal.

Literature published in 1987 on radioactive wastes in relation to water pollution control is summarized, including: national programs and waste repositories (waste processing and decommissioning, environmental transport, and remedial action and treatment). The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01493

RECENT DEVELOPMENTS IN THE LAW OF THE SEA 1984-1985,
For primary bibliographic entry see Field 6E.
W89-01515

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON SUBSURFACE INJECTION OF LIQUID WASTES.
New Orleans, Louisiana. March 3-5, 1986. National Water Well Association, Dublin, OH. 1986. 739p.

Descriptors: *Hazardous wastes, *Wastewater disposal, *Injection wells, *Groundwater pollution, *Disposal wells, Liquid wastes, Case studies, Waste management, Fate of pollutants, Path of pollutants, Deep wells, Models, Organic wastes, Radioactive wastes, Economic aspects.

The International Symposium on Subsurface Injection of Liquid Wastes was held in New Orleans, Louisiana, March 3-5, 1986. Government officials, industry representatives, consulting engineers and geologists, researchers and other interested persons met to learn and discuss state-of-the-art techniques employed and variables to consider in the operation of underground injection facilities. The conference papers address a wide variety of topics including: a point/counterpoint on the practice of underground injection, well construction and testing methods, case studies on the operation of selected facilities, and a discussion of the fate and transport of injected wastes. This conference provided a forum for all who attended to communicate and share experiences about the practice of subsurface disposal, to discuss state-of-the-art technology and to learn of future regulatory implications in the area of subsurface disposal. (See W89-01565 thru W89-01597) (Author's abstract)
W89-01564

DEEPER PROBLEMS: LIMITS TO UNDERGROUND INJECTION AS A HAZARDOUS WASTE DISPOSAL METHOD,
Natural Resources Defense Council, Inc., New York.
W. Gordon, and J. Bloom.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 3-50, 1 fig, 1 tab, 173 ref.

Descriptors: *Hazardous wastes, *Liquid wastes, *Waste disposal, *Injection wells, *Groundwater pollution, Path of pollutants, Water pollution prevention, Water pollution control, Disposal wells, Case studies, Waste management, Regulations.

The injection of hazardous waste into subsurface rock formations is at once both the predominant form of liquid hazardous waste disposal in the United States and one of the least understood. Despite the considerable reliance on underground injection for disposing of hazardous wastes, neither the effective injection of fluids nor their safe containment can presently be assured. This article analyzes the practice of underground injection as a hazardous waste disposal method and evaluates the limits to its use and the degree of protection against groundwater contamination current injection methods can ensure. It identifies specific research needs necessary to determine the technical and environmental constraints associated with underground injection and its potential for assuring complete containment of waste. Also examined is the U.S. Environmental Protection Agency's Underground Injection Control Program in terms of its adequacy in preventing and remedying groundwater contamination and other environmental damage due to migration of hazardous wastes. The article recommends specific regulatory changes that could result in more protective underground injection operations. (See also W89-01564) (Author's abstract)
W89-01565

UNDERGROUND INJECTION: A POSITIVE ADVOCATE,
National Water Well Association, Dublin, OH.
J. H. Lehr.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 51-56.

Descriptors: *Injection wells, *Hazardous wastes, *Waste disposal, *Disposal wells, Groundwater pollution, Drinking water, Path of pollutants, Deep wells, Landfills, Waste dumps, Land disposal, Case studies.

Under the auspices of the Safe Drinking Water Act (SDWA), the Environmental Protection Agency oversees the regulation of underground injection wells for the disposal of hazardous wastes. Prior to SDWA, the injection wells were adequately regulated by state agencies. In 1983, the Office of Drinking Water began examining Class 1 wells which inject hazardous wastes. The biggest users of hazardous waste injection wells are the chemical industries which account for nearly half the wells, and the petroleum refining industry accounts for nearly 25% of the wells. Contamination of groundwater from faulty injection operations has occurred in isolated cases where well construction

was improper, confining beds inadequate, and injection rates unreasonable. Cases of groundwater pollution from injection wells in Louisiana, Ohio, Texas, Florida, Colorado, and Oklahoma are reviewed. A case study in West Palm Beach, Florida, where planning, design, installation, operation and monitoring approach the best available practice to yield a safe and effective injection well system is described. This system relies on continuous measurement of injection rates and pressures at the well. The safe records of injection well disposal of hazardous wastes, compared to the poor record of pits, ponds, lagoons, landfills, and dumps should warrant few restrictions on this type of waste disposal. (See also W89-01564) (Geiger-PTT)
W89-01566

MECHANICAL INTEGRITY OF CLASS 1 INJECTION WELLS,
Texas World Operations, Inc., Houston, TX.
R. F. Whiteside, and S. F. Raef.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 57-76, 8 fig, 9 ref.

Descriptors: *Injection wells, *Disposal wells, *Waste disposal, *Hazardous wastes, *Site selection, Drilling, Deep wells, Training, Liquid wastes, Testing procedures.

The demonstration of injection well mechanical integrity is the foundation of the Underground Injection Control legislation. Without injection well mechanical integrity, wastes cannot be injected without some danger of contamination of potential drinking water supplies. This paper reviews the siting, construction, and testing of Class 1 disposal wells and how these are designed to ensure mechanical integrity. Periodic mechanical integrity testing is discussed, including pressure testing and logging, and the advantages and limitations of each technique. Advantages/disadvantages of packer-annulus versus packerless well completions are discussed as they pertain to annulus monitoring. Subsurface injection of liquid wastes is an environmentally safe practice provided wells are properly designed, maintained, and operated. With current well construction, monitoring, and testing technology, the most important requirement is a commitment by well managers to provide proper training to well operators and supervisors. (See also W89-01564) (Author's abstract)
W89-01567

CEMENTING TO ACHIEVE ZONE ISOLATION,
Haliburton Services, Duncan, OK.
C. George, and B. Thomas.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 77-89, 12 fig.

Descriptors: *Cements, *Disposal wells, *Waste disposal, *Injection wells, *Well drilling, Epoxy resins, Sealants, Pozzolans, Deep wells.

Zone isolation is a key element in the success of a disposal well and is a major criterion by which the success of a disposal well is determined. The state of the art cementing techniques developed for effective zone isolation for waste disposal are presented. Gelling preflush provides a prop against which the cement can be pumped, thus helping to avoid lost cement returns. Epoxy sealant is used on new completions. Epoxy resins, pozzolans and latex cement enhance the durability of sealed disposal wells. Corrosion resistant epoxy is designed to assist in the installation of new casing inside old, corroded casings. Job designs for long string and intermediate completions are presented and discussed. Other topics considered include cementing tools and proper water/cement ratios. Field results from sample zone isolation jobs are discussed. (See also W89-01564) (Author's abstract)
W89-01568

INDUSTRIAL WASTE DISPOSAL WELLS: MECHANICAL INTEGRITY,
Texas Water Commission, Austin.
B. Klemt, S. Pole, and R. MacKinnon.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 90-112, 13 fig, 1 ref.

Descriptors: *Injection wells, *Disposal wells, *Waste disposal, *Testing procedures, *Well drilling, Industrial wastes, Radioactive tracers, Leakage, Cements, Well casings, Case studies.

Injection wells have been used extensively since the 1950's to dispose of hazardous industrial liquid chemical wastes. Today, the principal method of determining the mechanical integrity of an operating industrial waste disposal well is the continuous monitoring of injection and casing-tubing annulus pressures. These pressures are monitored to confirm that no leakage through the tubular goods has occurred. Other mechanical integrity testing methods have come into routine use over the years because of regulations which require the following: (1) that there is no significant leak in the casing, tubing, or packer and, (2) that there is no significant fluid movement through vertical channels adjacent to the injection well casing. These additional mechanical integrity tests include periodic pressure testing of the tubular goods at higher than normal pressures, temperature logging, pipe surveys, radioactive tracer surveys, and cement bond logging. A review of case histories of injection well failures indicates that most failures involved: (1) the injection of acid wastewaters which caused pressurization of the disposal reservoir and/or deterioration of the injection well itself; (2) the lack of a systematic mechanical integrity testing program tailored to the individual waste disposal well; (3) well design and construction that was inadequate; and (4) an insufficient number of mechanical integrity testing methods to provide definitive information regarding locations of leaks in the casing, tubing, or packer, and fluid movement behind the casing. (See also W89-01564) (Author's abstract)
W89-01569

CLASS I INJECTION WELL DESIGN CONSIDERATIONS: USING FIBERGLASS TUBULARS AND EPOXY CEMENT,
Du Pont de Nemours (E.I.) and Co., Beaumont, TX.
For primary bibliographic entry see Field 8C.
W89-01570

TESTING AND REPAIR OF A LEAKING DEEP INJECTION WELL,
CH2M Hill, Inc., Gainesville, FL.
T. M. McCormick, and J. I. Garcia-Bengochea.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 133-147, 5 fig, 5 ref.

Descriptors: *Injection wells, *Disposal wells, *Aquitards, *Cements, *Well repair, *Leakage, Monitoring, Florida, Aquifers, Test wells, Liquid wastes, Waste disposal.

The City of Margate Injection Well-1 is a Class I well located in Broward County, Florida, and issued for the disposal of municipal secondary wastewater treatment plant effluent. The injection well discharges at a depth between 2,450 and 3,200 feet (747 and 975 m) below land surface into a highly transmissive cavernous strata of the lower Floridan aquifer, known locally as the Boulder Zone. Native water in the Boulder Zone contains approximately 35,000-mg/L total dissolved solids. After ten years of service a leak was detected by the open annulus monitor of the injection well. Initial investigations completed in February 1983 concluded that the casing seemed intact but that there was a small leak through the cement seal at the base of the injection casing. The decision was made to repair the open annulus monitor, thereby restoring the integrity of the overlying aquitards. Bullhead injection, or pumping cement from the surface down without the use of cement lines, was selected as the repair technique. A lightweight cement, Spherelite, was supplied and pumped by Halliburton Services in April 1985. The effectiveness of the repair was confirmed by radioactive tracing, geophysical logging, and continued monitoring with a new multi-zone monitor well installed during expansions of the Margate effluent disposal system. (See also W89-01564) (Author's abstract)
W89-01571

FACTORS EFFECTING THE AREA OF REVIEW FOR HAZARDOUS WASTE DISPOSAL WELLS,
Davis (Ken E.) Associates, Houston, TX.
K. E. Davis.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 148-194, 16 fig, 6 tab, 24 ref.

Descriptors: *Injection wells, *Hazardous wastes, *Waste disposal, *Disposal wells, *Cements, Drilling, Mathematical studies, Boreholes, Borehole geophysics, Liquid wastes.

The area of review for a hazardous waste disposal well is defined as the radial distance from the receiving well in which the pressure, caused by injection, increases sufficiently to possibly cause migration of fluids into useable sources of drinking water (USDW). Among the potential conduits for fluid migration from the disposal formation are improperly plugged well bores, channeling behind the casing of the injection well, faulted formations, solution channels, naturally fractured formations or facies pinch-outs. Usually faults, solution channels and most other naturally occurring geological conduits are filled with native fluids and are frequently sealed from USDWs by secondary mineralization. Only man-made conduits are described here. Man-made conduits such as old abandoned test holes or oil and gas wells are sealed with cement plugs and drilling mud. The static mud column provides substantial resistance to upward flow. Most mud systems develop a gel structure when allowed to remain quiescent. To initiate flow up an improperly abandoned well bore, the pressure in the disposal zone must exceed the sum of the static mud column pressure and the mud gel strength pressure. If the sum of these values is not exceeded during the life of a hazardous waste disposal well, there is no potential for contamination of USDWs. A simplified procedure is presented that can be used to calculate that effected area. (See also W89-01564) (Author's abstract)
W89-01572

FLUID SEALED CLASS I INJECTION WELLS,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
For primary bibliographic entry see Field 8C.
W89-01573

INTEGRITY TESTING OF CLASS I HAZARDOUS INJECTION WELLS: RELATED EXPERIENCE IN THE GREAT LAKES REGION,
Davis (Ken E.) Associates, Houston, TX.
M. D. Jarrell.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 211-240, 8 fig, 10 tab, 5 ref, 2 append.

Descriptors: *Liquid wastes, *Disposal wells, *Injection wells, *Radioactive tracers, *Testing procedures, Waste disposal, Hazardous wastes, Michigan, Indiana, Ohio, Illinois.

The U.S. Environmental Protection Agency (EPA) Region V has the primary regulatory authority for the Underground Injection Control (UIC) program in Michigan and Indiana. Ohio and Illinois have primacy over their individual state UIC programs. Under the programs, operators must periodically demonstrate the mechanical safety of certain types of injection wells. Currently there are no widely accepted standards for conducting these tests. The UIC programs identify general guidelines for testing. However, specific procedures are approved by the various agencies,

case be case, based on those proposed by the well operator. Mechanical integrity testing of Class I hazardous waste disposal wells in Region V is discussed, including test procedure development, implementation and interpretation. The test procedures are based on site specific well construction, operation and geological considerations. Testing methods include the radioactive tracer survey and annular pressure testing. The interpretation of test results are discussed as related to U.S. EPA's criteria for acceptance. The principals applied could prove helpful in establishing regional standards for mechanical integrity testing. (See also W89-01564) (Author's abstract)
W89-01574

MECHANICAL INTEGRITY RESEARCH,
Robert S. Kerr Environmental Research Lab., Ada, OK.
For primary bibliographic entry see Field 8C.
W89-01575

SIXTEEN SUCCESSFUL YEARS: A HISTORY OF STAUFFER CHEMICAL COMPANY'S UNDERGROUND INJECTION AT BUCKS, ALABAMA,
Joiner (Tom) and Associates, Tuscaloosa, AL.
K. P. Hanby.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 279-294, 8 fig, 9 ref.

Descriptors: *Injection wells, *Disposal wells, *Liquid wastes, *Waste disposal, Deep wells, Industrial wastes, Organic carbon, Monitoring, Alabama, Performance evaluation.

Stauffer Chemical Company has successfully operated deep well disposal systems at their plant in Bucks, Alabama, since 1969. Injection wells at this site are used to dispose of a waste stream characterized by high concentrations of salt, high chemical and biological oxygen demand, and trace amounts of total organic carbon. The rate of injection has averaged between 58 and 70 gpm (316.2 and 381.6 cu m/day) since 1969. Foremost in the success of Stauffer's deep well injection system is the existence of favorable geologic and hydrologic conditions. Two injection zones are used which have wide lateral extent, uniform porosity and permeability, are sealed above and below by impervious strata, and are void of any usable or economic resources. Well 1 began operation in August, 1969, Well 2 was completed in 1974 and Well 3 was drilled in 1982. At the surface, tubing-casing annulus pressures and injection pressures are continuously monitored to ensure continued integrity of the well and performance of the injection zones. Monitoring of the freshwater aquifers is conducted to ensure protection of water quality in the usable freshwater zones. Every two years the injection wells undergo a major workover which involves casing inspection, pulling the tubing, and running of electric logs. The area of waste movement can be estimated by relating volume of reservoir porosity to volume of injected wastes. The increase in disposal zone pressure resulting from injection can be calculated using a form of the diffusivity equation for solution of Darcy's law. Calculations show that the increase in reservoir pressure at the wells is minimal and at present rates of injection, the increase will be less than 20 psi (138 kPa) after 50 more years of injection. (See also W89-01564) (Author's abstract)
W89-01576

TWO DECADES OF SUCCESSFUL HAZARDOUS WASTE DISPOSAL WELL OPERATION: A COMPILATION OF CASE HISTORIES,
Davis (Ken E.) Associates, Houston, TX.
K. E. Davis, and T. L. Hineline.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 295-308, 5 fig.

Descriptors: *Injection wells, *Hazardous wastes, *Waste disposal, *Liquid wastes, *Disposal wells, Case studies, Environmental effects, Monitoring, Deep wells, Testing procedures, Performance evaluation.

There have been over 300 hazardous waste disposal wells installed in the continental United States during the past two decades and approximately 200 of these are currently operating. Less than 2% have caused environmental damage and current regulations will prevent this situation from reoccurring. The most common operational problems associated with disposal wells is plugging of the injection zone. This can be caused by inadequate pretreatment, incompatibility of the waste effluent with the connate waters and/or reservoir rock, incompatibility of commingled effluents injected into a common well, biological activity and the use of improper or dirty completion fluids. Most disposal wells have handled one or more of these problems resulting in years of successful operation with no environmental damage. The monitoring systems and mechanical integrity programs required by the federal and state UIC programs have an excellent record for detecting problem areas prior to any deleterious effects on the environment. Most alleged well failures are merely the improper operation of the monitor equipment and do not result in any environmental hazard. Well monitoring systems are built to identify potential problems and/or failures prior to any environmental damage. Case histories on how operational problems were identified and successfully eliminated are presented. Methods of identifying potential problems and repairing wells are described. (See also W89-01564) (Author's abstract)
W89-01577

OPERATION AND MAINTENANCE OF UNDERGROUND INJECTION WELLS,
Du Pont de Nemours (E.I.) and Co., Victoria, TX.
J. R. Buttram.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 309-318, 4 fig.

Descriptors: *Well maintenance, *Injection wells, *Waste disposal, *Disposal wells, *Industrial wastes, Deep wells, Monitoring, Well casings, Maintenance, Texas, Case studies.

The Du Pont chemical plant at Victoria, Texas has used underground injection wells for liquid wastes disposal for 33 years. The No. 1 well at the Victoria Plant was installed in 1953. The ten wells at the site have been operating for a total of 195 well years and have safely disposed of 16 billion gallons of aqueous waste. All of the wells at the Du Pont site consist of a surface casing, well casing, injection tubing, a packer providing a seal between the bottom of the injection tubing and the casing, and annulus fluid. The above ground facilities for waste conditioning consist of the following features: solids separation, pumping, and flow and pressure control. An operator performs visual inspection to determine any needed above-ground maintenance of the wells. After eliminating above ground sources of fluid loss, a hydrostatic test of the down hole annulus system should be performed before initiating workover procedures. Over the years, the following types of down hole repairs have been required at Victoria: well casings, injection tubing, tubing thread problems, packer seal, sand bridges, and formation unplugging. None of the problems encountered have resulted in any environmental damage. (See also W89-01564) (Geiger-PTT)
W89-01578

STUDY OF CURRENT UNDERGROUND INJECTION CONTROL REGULATIONS AND PRACTICES IN ILLINOIS,
Illinois State Water Survey Div., Champaign.
A. P. Visocky, G. R. Peyton, J. S. Nealon, R. D. Brower, and I. Krapac.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 319-329, 3 fig, 2 ref.

Descriptors: *Injection wells, *Hazardous wastes, *Waste disposal, *Disposal wells, *Regulations, *Illinois, Industrial wastes, Deep wells, Monitoring.

In 1984 Illinois State the Department of Energy and Natural Resources was required to assess the regulations and practices of the Illinois Underground Injection Control (UIC) program as it relates to Class I hazardous waste disposal wells. Nine injection wells, including two standbys, are currently in operation at seven sites. These wells range in depth from 1540 to 5524 feet (470 to 1683 meters) and inject wastes mostly into porous carbonate formations (two wells inject into a thick sandstone). In 1984, approximately 300 million gallons (1.1 billion liters) of industrial wastes were disposed of in these wells. Acids were the most common waste disposed of, although water made up 70 to 95% of the wastes by volume. Illinois has been granted primacy in operating this program. The geologic environment, consisting of the unit accepting the waste and confining units lying above and below, has the capacity to accept the waste, to retain it, and to protect all underground sources of drinking water (USDW) from contamination by its injection. The geology of Illinois is relatively simple and includes disposal zones and associated confining units suitable for deep-well injection across the central two-thirds of the state. The regulatory structure for Class I injection wells is generally adequate in concept and scope to ensure containment of injected wastes and to safeguard underground sources of drinking water in Illinois. There is a need to update and strengthen selected portions of the regulatory practices in the areas of waste sampling protocol, chemical analysis of collected waste samples, and evaluation of well testing and monitoring data. (See also W89-01564) (Author's abstract)
W89-01579

SITE SUITABILITY FOR WASTE INJECTION, VICKERY, OHIO,
Underground Resource Management, Inc., Austin, TX.
M. E. Bentley, R. T. Kent, and G. R. Myers.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 330-354, 10 fig, 21 ref.

Descriptors: *Injection wells, *Disposal wells, *Liquid wastes, *Waste disposal, *Site selection, *Ohio, Well casings, Aquifers, Hydraulic gradients, Groundwater movement, Dolomite.

An array of six commercial injection wells dispose of liquid waste, primarily steel pickling liquor, into the Mt. Simon Sandstone at pressures up to 700 psi. The Mt. Simon Sandstone is a well cemented, very fine to coarse-grained, partially arkosic sandstone that lies at a depth of approximately 2,800 feet. Well tests indicated that the flow capacity of the Mt. Simon is approximately 3,000 to 4,500 md-ft. Injection of 30 gallons per minute into each of six wells at the site is calculated to cause head increases in the Mt. Simon to above land surface in an area approximately 16,000 feet in diameter. Tests of the Shady Dolomite, the unit that immediately overlies the Mt. Simon, employed the same standard oil field core testing methods that were used on Mt. Simon samples; the lower limit of measurable rock permeability was 0.01 md. Examination of thin sections of samples of the dolomite indicated that microfractures exist with apertures of approximately 0.1 mm or smaller; the fractures appear to be mostly filled with dolomitic cement. Groundwater is present in the shallow glacial deposits and in the underlying Big Lime. A thick sequence of shale and fine-grained carbonate rocks separate the base of fresh water from the injection zone. Early cable-tool petroleum drilling, focused on the Trenton Formation, apparently did not penetrate to the depth of the Mt. Simon. Records indicate that modern-era exploratory holes to the Mt. Simon sandstone have been properly plugged. The potentiometric level in the Mt. Simon at the site is approximately 300 feet below ground level. Previous studies of the natural hydrodynamics of the Mt. Simon Sandstone indicate that the hydraulic gradient within the formation is relatively flat, as suggested by the conflicting directions of inferred movement that have resulted from different assumptions of fluid density. The rates of migration

are estimated to be on the order of 0.5 foot or less per year. (See also W89-01564) (Author's abstract)
W89-01580

REMEDIATION OF GROUND-WATER CONTAMINATION RESULTING FROM THE FAILURE OF A CLASS I INJECTION WELL: A CASE HISTORY,
Louisiana Dept. of Natural Resources, Baton Rouge. Injection and Mining Div.
For primary bibliographic entry see Field 5G.
W89-01581

HYDROGEOLOGY OF SEDIMENTARY BASINS AS IT RELATES TO DEEP-WELL INJECTION OF CHEMICAL WASTES,
Texas Univ. at Austin. Bureau of Economic Geology.
For primary bibliographic entry see Field 2F.
W89-01583

EVALUATION OF CONFINING LAYERS FOR CONTAINMENT OF INJECTED WASTEWATER,
Missouri Univ.-Rolla. Dept. of Geological Engineering.
For primary bibliographic entry see Field 2F.
W89-01584

APPLICATION OF FLOW, MASS TRANSPORT, AND CHEMICAL REACTION MODELING TO SUBSURFACE LIQUID INJECTION,
Prickett (Thomas A.) and Associates, Urbana, IL.
T. A. Prickett, D. L. Warner, and D. D. Runnells.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 447-463, 59 ref.

Descriptors: *Site selection, *Model studies, *Injection wells, *Disposal wells, *Mathematical models, *Path of pollutants, *Waste disposal, Fate of pollutants, Sorption, Advection, Numerical analysis, Fluid flow, Liquid wastes, Reservoirs, Hydrologic models.

Mathematical modeling using analytical or numerical methods is an essential process in injection well site evaluation. Modeling is necessary for estimation of pressure buildup rates at the injection well and pressure buildup distribution in the injection reservoir. As injection proceeds such modeling may be continued and the model adjusted to reflect new information on reservoir properties that is obtained during operation. An extensive variety of analytical equations and many suitable numerical models are available for this purpose. Modeling of the fate and transport of injected chemicals is less commonly done but can also be carried out with analytical equations or numerical models. The processes involved during contaminant transport include, at least, advection and dispersion and may also involve sorption, decay, and chemical and biochemical reaction. Currently available models can deal with advection and dispersion and, to some extent, with sorption and decay. However, no present model can incorporate the full complexity of the transport of a complex chemical waste in a deep, high-pressure, high-temperature, high-salinity, subsurface environment. While it is not presently possible to fully simulate the transport of chemical contaminants injected through deep wells, the worst case situation of conservative chemical transport can be modeled. Future developments in coupled transport-chemical reaction modeling are needed to allow incorporation of all important attenuation mechanisms so that a more realistic prediction of the long-term fate of injected chemicals can be made. (See also W89-01564) (Author's abstract)
W89-01585

ANALYSIS OF THE MIGRATION PATTERN OF INJECTED WASTES,
Oklahoma Univ., Norman. School of Petroleum and Geological Engineering.
For primary bibliographic entry see Field 2F.
W89-01586

COMPARISON OF ANALYTICAL AND NUMERICAL METHODS FOR EVALUATING CROSS-FORMATIONAL FLOW AND SELECTING THE PREFERRED INJECTION AQUIFER, SWAN HILLS, ALBERTA, CANADA,
Alberta Research Council, Edmonton. Basin Analysis Group.
For primary bibliographic entry see Field 2F.
W89-01587

INJECTION ZONE PRESSURE PROFILE,
Du Pont de Nemours (E.I.) and Co., Victoria, TX.
J. C. Frank.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 509-519, 5 fig.

Descriptors: *Injection wells, *Wastewater disposal, *Disposal wells, *Water pressure, *Computer models, Mathematical models, Flow rates, Case studies, Texas, Monitoring.

The Du Pont plant near Victoria, Texas, began using injection wells for wastewater disposal in 1953. In 1972, a computer model was developed based on the Illinois State Water Survey Model to predict the pressure profile within the injection zone as a means of assuring environmental integrity. The model calculates incremental pressure increases above an initial (pre-injection) bottom hole pressure within a fifty square mile area surrounding the injection area. Accuracy of the model was validated using pressures measured in a static monitoring well during a three year period. In 1974, the computer model was used to predict the pressure rise in the injection zone at potential points of communication. It showed the pressure rise at that time was not sufficient to lift native brine to the surface. However, the rate of increase would be potentially sufficient to do so in the future. Based on this information, a program was initiated to reduce waste injection rates into the Catahoula zone. Using information from the computer model, injection rates and, therefore, pressure in the injection zone should remain within safe limits. (See also W89-01564) (Geiger-PTT)
W89-01588

FLOW AND CONTAINMENT OF INJECTED WASTES,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
C. Miller, T. A. Fischer, J. E. Clark, W. M. Porter, and C. H. Hales.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 520-559, 14 fig, 2 tab, 43 ref.

Descriptors: *Model studies, *Injection wells, *Disposal wells, *Wastewater disposal, *Mathematical models, Path of pollutants, Deep wells, Texas, Flow rates, Environmental effects, Geohydrology, Plumes, Groundwater movement.

A variety of mathematical models were developed to analyze the flow and containment of wastes within an injection formation from the standpoint of (1) area of review criteria (waste plume location and pressure distribution), and (2) potential for upward migration. These models have been applied to the specific circumstances of the Du Pont Victoria, Texas injection site. A new equation provides a simple method for calculating maximum upward permeation into an intact confining layer. The density effects can be very important in influencing waste plume location and upward migration potential, and the models are capable of quantifying these effects. Simple flow and pressure models are used to establish sound technical strategies for estimating the extreme outer boundary of the injected waste plume, and the area over which pressure increases in the injection zone could cause fluid migration up an unplugged abandoned hole to an Underground Source of Drinking Water (USDW). A geological feature, often present at an injection site, can prevent wastes from reaching the USDW in a worst-case scenario. This feature is a stack of intervening confining layers and permeable layers sandwiched between the injection formation and the lowest USDW. (See also W89-01564) (Author's abstract)
W89-01589

CHEMICAL FATE OF INJECTED WASTES,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
For primary bibliographic entry see Field 5B.
W89-01590

DEEP-WELL INJECTION OF AQUEOUS HYDROCHLORIC ACID,
Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
A. Z. Panagiotopoulos, and R. C. Reid.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 610-637, 12 fig, 27 ref, append.

Descriptors: *Injection wells, *Disposal wells, *Wastewater disposal, *Blowouts, *Brine disposal, *Hydrochloric acid, Acidic water, Carbon dioxide, Limestone, Dolomite, Models, Performance evaluation, Reliability.

Disposal of dilute hydrochloric acid by deep-well injection into carbonate formations is widely practiced, particularly in the mid-western area of the United States. After examining many of the engineering aspects of this operation including injection-well pressure drops, rates of dissolution, enthalpies of neutralization, and the solubility of product carbon dioxide in the chloride-salt brine, we conclude (1) that the carbon dioxide dissolves in the formation brine if the injection acid does not exceed about 6 weight percent, (2) injection acid reacts close to the cavity wall and does not penetrate far into either limestone or dolomite, and (3) temperature increases are only of the order of a few degrees Centigrade for the neutralization reaction (when 6 weight percent acid is used). In addition, limiting-case models are proposed to indicate the cavity size after various times of injection. A well-blowout is described and interpreted in terms of the geysering phenomenon; from the model it is possible to estimate, approximately, the lag time one might expect, before operational problems arise, after a step-increase in injected-acid concentration. Estimated lag times are in reasonable agreement with the few experimental facts available. (See also W89-01564) (Author's abstract)
W89-01591

ROLE OF THE CRITICAL TEMPERATURE OF CARBON DIOXIDE ON THE BEHAVIOR OF WELLS INJECTING HYDROCHLORIC ACID INTO CARBONATE FORMATIONS,
Environmental Protection Agency, Chicago, IL. Region V.
K. Kamath, and M. Salazar.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 638-655, 3 fig, 6 ref.

Descriptors: *Injection wells, *Hydrochloric acid, *Wastewater disposal, *Blowouts, *Disposal wells, *Carbon dioxide, Liquid wastes, Great Lakes Region, Industrial wastes, Deep wells, Temperature effects, Theoretical analysis.

The natural consequence of the emplacement of industrial waste hydrochloric acid in subsurface carbonate formations by deep well injection, is the dissolution of the carbonate matrix minerals to yield soluble chlorides and bicarbonates by two consecutive, exothermic chemical reactions. Fundamental considerations of the phase behavior of carbon dioxide, an intermediate product of the reaction, indicate that the safe and trouble-free operation of a well injecting acid into a carbonate formation is predicated upon one primary condition: that the produced carbon dioxide associated with the fluids around the wellbore and which may encroach into the well be in the liquid, not gaseous, state. This condition will be easily met in deep wells; but only if the effective temperature of the acid is below 88 F, the critical temperature of

carbon dioxide. Injection of acid at higher temperatures may cause the formation of a gaseous carbon dioxide phase leading to vapor locks in the tubing, loss of well injectivity and finally, a well blowout. In the final analysis, the immediate threat to the environment from such acid disposal, is not so much from the products of the chemical reaction between acid and carbonate, or even from the possible collapse of the injection zone on account of its slow dissolution by acid, but rather from well blowouts resulting from acid injection at temperatures above 88 F. The key to the operational safety of such wells, thus appears to be the cooling of the injected acid substantially below 88 F, a condition now generally met, though fortuitously, during conventional storage of the acid in open ponds prior to injection. The validity of these theoretical considerations is illustrated by the documented operational history as well as the circumstances leading to the blowout of an example well in the Great Lakes Region. (See also W89-01564) (Author's abstract)
W89-01592

SUBSURFACE DISPOSAL OF LIQUID LOW-LEVEL RADIOACTIVE WASTES AT OAK RIDGE, TENNESSEE,
Oak Ridge National Lab., TN.
S. H. Stow, and C. S. Haase.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 656-675, 7 fig, 1 tab, 26 ref. U.S. Department of Energy Contract No. DE-AC05-840R21400.

Descriptors: *Injection wells, *Radioactive wastes, *Disposal wells, *Wastewater disposal, *Tennessee, *Oak Ridge National Laboratory, Liquid wastes, Aquitards, Path of pollutants, Monitoring, Hazardous wastes, Cos analysis.

At Oak Ridge National Laboratory (ORNL) subsurface injection has been used to dispose of low-level liquid nuclear waste for the last two decades. The process consists of mixing liquid waste with cement and other additives to form a slurry that is injected under pressure through a cased well into a low-permeability shale at a depth of 300 m (1000 ft). The slurry spreads from the injection well along bedding plane fractures and forms solid grout sheets of up to 200 m (660 ft) in radius. Using this process, ORNL has disposed of over 1500,000 Ci of activity; the principal nuclides are Sr90 and Cs137. In 1982, a new injection facility was put into operation. Each injection, which lasts some two days, results in the emplacement of approximately 750,000 l (180,000 gal) of slurry. Disposal cost per liter is approximately $0.30, including capital costs of the facility. This subsurface disposal process is fundamentally different from other operations. Wastes are injected into a low-permeability aquitard, and the process is designed to isolate nuclides, preventing dispersion in groundwaters. The porosity into which wastes are injected is created by hydraulically fracturing the host formation along bedding planes. The site is in the structurally complex Valley and Ridge Province. The stratigraphy consists of lower Paleozoic rocks. Investigations are under way to determine the long-term hydrologic isolation of the injection zone and the geochemical impact of saline groundwater on nuclide mobility. Injections are monitored by gamma-ray logging of cased observation wells to determine grout sheet orientation after an injection. Recent monitoring work has involved the use of tiltmeters, surface uplift surveys, and seismic arrays. Recent regulatory constraints may cause permanent cessation of the operation. Federal and state statutes, written for other types of injection facilities, impact the ORNL facility. This disposal process, which may have great applicability for disposal of many wastes, including hazardous wastes, may not be developed for future use. (See also W89-01564) (Author's abstract)
W89-01593

TREATMENT AND DISPOSAL TECHNOLOGIES FOR LIQUID HAZARDOUS WASTES ALTERNATIVES TO SUBSURFACE INJECTION,
Engineering-Science, Inc., Atlanta, GA.
M. A. Guthrie, G. Patrick, and T. N. Sargent.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 676-690, 2 tab.

Descriptors: *Injection wells, *Disposal wells, *Wastewater disposal, *Wastewater treatment, Waste management, Liquid wastes, Organic wastes, Anaerobic digestion, Aerobic digestion, Adsorption, Reverse osmosis, Electrodialysis, Deep wells, Hazardous wastes, Underground Injection Control.

Currently Underground Injection Control (UIC) Programs are being reviewed by various state and federal agencies. This review may result in additional treatment requirements of the waste prior to deep well disposal or a total ban of deep-well injection of hazardous wastes. A ban of deep well injection would result in disposal to a receiving stream or publicly owned treatment works (POTW), recycle/recovery, incineration or solidification/fixation. Regardless of the disposal method, some level of treatment will be required. Eight categories of liquid wastes, each representing a class of chemical contaminants sharing the same general characteristics, were identified. The most successful treatment technologies that have been applied for each category of waste were presented. The treatment technologies were evaluated to allow federal and state regulatory agencies, consultants, and plant engineers to apply the technologies to a particular waste stream. The technologies evaluated in the report ranged from common methods such as pH neutralization to advanced processes such as membrane separation (e.g., reverse osmosis and electrodialysis). Each treatment technology presented in this report has certain capabilities and limitations. For example, sulfide precipitation for removal of heavy metals produces a better effluent quality than hydroxide precipitation, but the sulfide reagent is more difficult to handle. Air stripping is more economically attractive than carbon adsorption for removal of high concentrations of volatile organic compounds. Therefore, it should be used prior to carbon adsorption. The disadvantage of aerobic biological processes for treatment of organic wastes is the generation of biological solids, whereas anaerobic treatment produces much less solids. In addition disposal of liquid aqueous wastes may employ several treatment technologies prior to discharge into a deep well system, to a receiving stream or to a POTW. (See also W89-01564) (Author's abstract)
W89-01594

ECONOMIC IMPACTS OF ALTERNATIVE TECHNOLOGIES FOR TREATMENT AND DISPOSAL OF LIQUID HAZARDOUS WASTES,
Engineering-Science, Inc., Atlanta, GA.
M. A. Guthrie, G. Patrick, and T. N. Sargent.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 691-714, 6 tab, 6 ref.

Descriptors: *Injection wells, *Wastewater disposal, *Liquid wastes, *Waste management, *Wastewater treatment, *Cost analysis, Disposal wells, Illinois, Deep wells, Reverse osmosis, Electrodialysis, Chemical precipitation, Evaporation, Activated carbon, Adsorption, Chlorination, Ion exchange, Economic aspects, Underground Injection Control.

The Underground Injection Control (UIC) Programs are currently being reviewed by federal and state regulatory agencies. This review may result in either minor regulatory changes in the UIC program, elimination of disposal by underground injection, or treatment required prior to deep well injection. Regardless, the total annual costs will increase as a result of changes to existing UIC programs. The total annual costs associated with treatment of liquid aqueous wastes can be divided into (1) total capital investment which is the one-time engineering and construction costs of the project, (2) the direct operating costs which are the annual costs for labor, power, materials, fuel and chemicals and (3) other costs which include taxes and insurance, overhead, depreciation, interest, and general and administrative expenses. To develop total annual costs several assumptions such as the level of treatment required and the method of disposal must be determined. The costs associated with the various treatment technologies are a function of the influent flowrate or mass loading. Where treatment technologies such as metal precipitation, reverse osmosis, ion exchange, or evaporation only concentrate a waste contaminant, a cost must be assigned to dispose of the spent brine by technologies such as solidification/fixation. Other technologies such as chemical oxidation, pH neutralization or carbon adsorption generally do not result in a residue that must be disposed. The total annual costs developed were applied to seven industries in Illinois that dispose of aqueous wastes by deep well injection. The capital investment cost for the industries ranged from 2.0 to 7.0 million dollars. The annual costs were estimated to range from 3.2 to 26.9 million dollars. The cost data developed by this study can be used to establish the economic costs for other wastes that are currently disposed by injection wells. (See also W89-01564) (Author's abstract)
W89-01595

SUPERCRITICAL DEEP WELL WET OXIDATION OF LIQUID ORGANIC WASTES,
Vertox, Inc., Dallas, TX.
For primary bibliographic entry see Field 5D.
W89-01596

FOCUS ON RESEARCH NEEDS,
Texas Univ. at Austin.
R. J. Charbeneau.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 733-739, 2 tab.

Descriptors: *Waste disposal, *Injection wells, *Hazardous wastes, *Research priorities, Geohydrology, Geochemistry, Path of pollutants, Fate of pollutants, Monitoring, Environmental effects, Resource Conservation and Recovery Act.

The 1984 amendments to the Resource Conservation and Recovery Act (RCRA) mandate that as of August 1988, EPA must prohibit the disposal of specified hazardous wastes in underground injection wells unless the Administrator determines the prohibition is not required in order to protect human health and the environment for as long as the waste remains hazardous. There are a number of research needs which must be addressed in order to make such determinations which may be favorable to continued underground injection. This paper reviews the research needs recognized by a number of individuals concerned with subsurface injection. Broadly, these are categorized as those concerned with advances in technology, confinement, hydrogeology and subsurface flow, geochemistry and waste transport and fate, monitoring, and risk analysis. Specific items are discussed and a rough prioritization is suggested. (See also W89-01564) (Author's abstract)
W89-01597

SLURRY CUTOFF WALLS: APPLICATIONS IN THE CONTROL OF HAZARDOUS WASTES,
Geo-Con, Inc., Pittsburgh, PA.
For primary bibliographic entry see Field 5G.
W89-01613

SUBSURFACE POLLUTION CONTAINMENT USING A COMPOSITE SYSTEM VERTICAL CUTOFF BARRIER,
Wehran Engineering Corp., Middletown, NY.
For primary bibliographic entry see Field 5G.
W89-01614

EVALUATION OF TWO METHODS FOR CONSTRUCTING VERTICAL CUTOFF WALLS AT WASTE CONTAINMENT SITES,
American Colloid Co., Skokie, IL.
For primary bibliographic entry see Field 5G.

W89-01616

INFLUENCE OF INORGANIC PERMEANTS UPON THE PERMEABILITY OF BENTONITE,
International Minerals and Chemical Corp., Detroit, MI.
For primary bibliographic entry see Field 5G.
W89-01617

PERMEABILITY OF CLAY TO ACIDIC AND CAUSTIC PERMEANTS,
Missouri Univ., Rolla.
For primary bibliographic entry see Field 5B.
W89-01621

EFFECT OF ORGANIC FLUIDS ON HYDRAULIC CONDUCTIVITY OF COMPACTED KAOLINITE,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W89-01624

LABORATORY COMPARISON OF THE EFFECTS OF WATER AND WASTE LEACHATE ON THE PERFORMANCE OF SOIL LINERS,
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 8D.
W89-01625

EFFECT OF ORGANIC FLUIDS ON THE PORE SIZE DISTRIBUTION OF COMPACTED KAOLINITE,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W89-01626

EFFECTS OF BRINE ON THE SOIL LINING OF AN EVAPORATION POND,
Bureau of Reclamation, Denver, CO.
For primary bibliographic entry see Field 5B.
W89-01627

INTERACTIONS BETWEEN ACIDIC SOLUTIONS AND CLAY LINERS: PERMEABILITY AND NEUTRALIZATION,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 8D.
W89-01628

DESICCATION CRACKING OF SOIL BARRIERS,
Hart Crowser, Inc., Seattle, WA.
For primary bibliographic entry see Field 5B.
W89-01630

FIELD PERMEABILITY TEST FOR CLAY LINERS,
Geo-Con, Inc., Pittsburgh, PA.
For primary bibliographic entry see Field 7B.
W89-01631

PERMEABILITY OF FLY ASH AND FLY ASH-SAND MIXTURES,
Wisconsin Power and Light Co., Madison, WI.
For primary bibliographic entry see Field 5G.
W89-01632

SOIL-CEMENT LINERS,
Portland Cement Association, Skokie, IL. Energy and Water Resources Dept.
For primary bibliographic entry see Field 8D.
W89-01633

HAZARDOUS AND INDUSTRIAL SOLID WASTE TESTING AND DISPOSAL: SIXTH VOLUME.
For primary bibliographic entry see Field 7B.
W89-01634

LEACHING TEST CHARACTERIZATION OF IRON AND STEEL INDUSTRY WASTE,
Thyssen A.G., Duisburg (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W89-01635

COMPARISON OF LEACHATE QUALITY IN FOUNDRY WASTE LANDFILLS TO LEACH TEST ABSTRACTS,
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W89-01636

TESTING METHODOLOGIES FOR LANDFILL CODISPOSAL OF MUNICIPAL AND INDUSTRIAL WASTES,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-01637

APPROACH FOR EVALUATING LONG-TERM LEACHABILITY FROM MEASUREMENT OF INTRINSIC WASTE PROPERTIES,
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
For primary bibliographic entry see Field 5A.
W89-01638

USE OF AN UPFLOW COLUMN LEACHING TEST TO STUDY THE RELEASE PATTERNS OF HEAVY METALS FROM STABILIZED/SOLIDIFIED HEAVY METAL SLUDGES,
Army Environmental Hygiene Agency, Aberdeen Proving Ground, MD. Waste Disposal Engineering Div.
For primary bibliographic entry see Field 5A.
W89-01639

LEACHATE MIGRATION THROUGH CLAY BELOW A DOMESTIC WASTE LANDFILL, SARNIA, ONTARIO, CANADA: CHEMICAL INTERPRETATION AND MODELLING PHILOSOPHIES,
University of Western Ontario, London. Geotechnical Research Centre.
For primary bibliographic entry see Field 5B.
W89-01640

LOW-COST DATA MANAGEMENT FOR PROTECTION OF GROUND-WATER RESOURCES: THE IMPORTANCE OF QUALITY ASSURANCE,
Louisiana Dept. of Environmental Quality, Baton Rouge.
For primary bibliographic entry see Field 7C.
W89-01641

PRINCIPLES OF BIORECLAMATION OF CONTAMINATED GROUND WATER AND LEACHATES,
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-01644

USE OF FLEXIBLE MEMBRANE LINERS FOR INDUSTRIAL AND HAZARDOUS WASTE DISPOSAL,
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
R. M. Koerner.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 195-207, 5 fig, 3 tab, 7 ref.

Descriptors: *Liners, *Membranes, *Landfills, *Hazardous wastes, *Waste disposal, Solid waste disposal, Leachates, Slope stability, Polymers, Rubber, Flexible membrane liners, Design criteria, Construction, Linings.

An overview of synthetic liners, called flexible membrane liners (FMLs), as used in the containment of solid wastes and their leachates in landfills is presented. The major types of FMLs in current use (plastics, rubbers, and combinations of materials) are discussed. Tests for chemical compatibility of the FML and the waste it is to contain can take the form of immersion tests, tub tests or pouch tests. The design criteria to be considered once the liner material has been selected include geometric configurations, cross section for leachate collection systems, thickness, side slopes, cover soil, runout length and anchor trench, and caps and closures to prevent infiltration. Construction details such as seams, seam inspection, and leak location methods are discussed. Areas of concern, which should be addressed as soon as possible, are: (1) development of test methods simulating in-service behavior of the FML; (2) development of test methods and standards for FMLs; (3) procedures for synthesizing landfill leachates, (4) test procedures for predicting chemical compatibility, including accelerated ageing tests; (5) automated field seaming methods; (6) more reliable and easier to use field seam test methods; and (7) development of leak location methods. (See also W89-01634) (Author's abstract)
W89-01645

MIGRATION OF LEACHATE SOLUTION THROUGH CLAY LINER AND SUBSTRATE,
McGill Univ., Montreal (Quebec).
For primary bibliographic entry see Field 5B.
W89-01646

EFFECT OF PORE FLUID PH ON THE DYNAMIC SHEAR MODULUS OF CLAY,
Lehigh Univ., Bethlehem, PA. Environmental Geotechnology Lab.
For primary bibliographic entry see Field 8D.
W89-01647

REMOTE SENSING METHODS FOR WASTE SITE SUBSURFACE INVESTIGATIONS AND MONITORING,
Office of Radiation Programs, Las Vegas, NV.
For primary bibliographic entry see Field 7B.
W89-01648

COMPLEX MATRIX IN ENVIRONMENTAL CHEMISTRY FOR THE PETROCHEMICAL INDUSTRY,
Standard Oil Co. (Ohio), Cleveland. Research Center.
For primary bibliographic entry see Field 5A.
W89-01649

DETERMINATION OF SOME MACRONUTRIENTS AND MICRONUTRIENTS AND SOME TOXIC ELEMENTS IN SEWAGE SLUDGES FROM DOMESTIC AND INDUSTRIAL INFLUENTS PRIOR TO LAND DISPOSAL: I. DEVELOPMENT OF METHODS,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W89-01650

WASTE IMMOBILIZATION IN CEMENT-BASED GROUTS,
Oak Ridge National Lab., TN. Chemical Technology Div.
T. M. Gilliam, L. R. Dole, and E. W. McDaniel.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 295-307, 3 fig, 8 tab, 11 ref. U.S. Department of Energy Contract DE-AC05-840R21400.

Descriptors: *Waste immobilization, *Cements, *Waste disposal, *Hazardous wastes, *Grouting, fly ash, Industrial wastes, Sludge disposal, Heavy metals, Polychlorinated biphenyls, Pesticides, Organic compounds, Leaching, Groundwater pollution, Path of pollutants, Chlorinated hydrocarbons, Feasibility studies, Chromium, Copper, Manganese, Lead, Arsenic.

The immobilization of industrial and hazardous wastes in cement-based grouts is shown to be technically feasible and offers an improved method of waste disposal. Experiments were performed on four simulated waste streams immobilized in cement-based grouts: (1) fly ash; (2) spent limestone scrubber solids; (3) pickling liquor and recovery sludge containing arsenic, cadmium, chromium, copper, manganese, and lead; and (4) a vacuum pump oil containing polychlorinated biphenyls (PCBs), Lindane (hexachlorocyclohexane), pentachlorophenol, and 9-9'-dichlorofluorene. The classes of organic compounds represented by this fourth waste are PCB, chlorinated cyclohexane, chlorinated phenol, and PNA. Leach tests were performed with a simulated groundwater typical of aquifers found in Maryville limestone. (See also W89-01634) (Author's abstract)
W89-01651

PROCESS TECHNOLOGY FOR THE BIOLOGICAL TREATMENT OF TOXIC ORGANIC WASTES,
Delaware Univ., Newark. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-01652

SOIL MOISTURE MONITORING AND SAMPLING PROBE FOR UNDERGROUND STORAGE TANKS AND SURFACE IMPOUNDMENTS,
Wisconsin Univ., Madison. Dept. of Soil Science.
For primary bibliographic entry see Field 5A.
W89-01654

ASTM STANDARD LEACH TEST D3986: A HISTORY,
U.S. Pollution Control, Inc., Oklahoma City, OK.
For primary bibliographic entry see Field 5A.
W89-01656

RESULTS OF AN INTERLABORATORY STUDY OF A COLUMN METHOD FOR LEACHING SOLID WASTES,
Western Michigan Univ., Kalamazoo.
For primary bibliographic entry see Field 5B.
W89-01657

EVALUATION OF PAINT FILTER TEST METHOD TO DETERMINE FREE LIQUID IN WASTE SAMPLES,
Empire-Thomsen, Groton, NY.
M. B. Rinaldo-Lee.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 409-416, 1 fig, 3 tab, 3 ref.

Descriptors: *Waste analysis, *Waste characteristics, *Testing procedures, Waste disposal, Landfills, Hazardous wastes, Paint filter test, Statistics.

The results from a round-robin testing program to evaluate the paint filter test method developed by the U.S. Environmental Protection agency (EPA) to determine whether a waste contains free liquid are presented. Regulations prohibiting disposal of waste containing free liquids in landfills were the impetus for developing the test method. Six laboratories performed the paint filter test on four waste samples to determine (1) whether the waste contained free liquid and (2) the percent free liquid released by the waste. The four waste samples were from two wastes; one waste was mixed with three different amounts of water to provide three waste samples. The results show a large variance between the laboratories. The large variance is attributed mainly to sample preparation. The participating laboratories noted two other major problems with the test: (1) separation of the mesh from the cardboard filter holder during testing and (2) differences in filter design, which could influence test results. (See also W89-01634) (Author's abstract)
W89-01659

LABORATORY AND WASTE MANAGEMENT FOR SAFETY AND REGULATORY COMPLIANCE,
Browning-Ferris Industries, Houston, TX. Houston Lab.
T. M. McKee, and R. C. Allison.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 417-425, 1 tab, 5 ref.

Descriptors: *Waste management, *Laboratory wastes, *Waste characteristics, *Waste disposal, *Hazardous wastes, Solid waste disposal, Landfills, Waste dumps, Safety, Regulations.

Federal, state, and local rules and regulations often affect even small generators of waste materials. Chemical laboratories are perfect examples with a need to develop procedures to dispose of small quantities of laboratory wastes in a safe and environmentally acceptable manner. Recognizing a need, the American Society for Testing and Materials D-34 committee on waste disposal created its Subcommittee D34.01.05 on Sample Disposal with the direct responsibility for developing guidelines for laboratories. While it was impossible to address the disposal of all wastes from all types of laboratories, the guidelines did address the more common laboratory waste streams. They are applicable, but not limited to, analytical chemistry, process control, and research or life science laboratories. The recommended guidelines for disposal cover the following topics: (1) the classification of waste for shipping and manifesting by common or generic name and by Department of Transportation requirements; (2) the segregation of wastes for recovery, pretreatment, or disposal; (3) the procedures for recovery of materials, or to render them nonhazardous and amenable for landfilling or in-house disposal, or to prepare them for disposal in authorized chemical disposal sites; and (4) the designation of a specific recovery or pretreatment and disposal method for each type of waste. (See also W89-01634) (Author's abstract)
W89-01660

HOW TO ASSESS THE HAZARDOUS GROUND WATER CONTAMINATION POTENTIAL OF UNCONTROLLED WASTE SITES,
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
For primary bibliographic entry see Field 5B.
W89-01668

DISPOSAL SITE MONITORING DATA: OBSERVATIONS AND STRATEGY IMPLICATIONS,
Lockheed Electronics Co., Inc., Las Vegas, NV.
For primary bibliographic entry see Field 5B.
W89-01669

POTENTIAL RISKS TO A SOLE-SOURCE AQUIFER RECHARGE AREA FROM WASTE DISPOSAL ACTIVITIES: A CASE STUDY,
Geological Survey, Baton Rouge, LA.
For primary bibliographic entry see Field 5B.
W89-01670

CASE STUDY OF THE EFFECTS OF BRINE ON A COMPACTED CLAY TILL LINER,
Golder Associates, Vancouver (British Columbia).
For primary bibliographic entry see Field 8D.
W89-01671

SWAN HILLS FACILITY OF ALBERTA SPECIAL WASTE MANAGEMENT CORPORATION: EVALUATION FOR DEEP WASTE DISPOSAL,
Alberta Research Council, Edmonton.
B. Hitchon, C. M. Sauveplane, S. Bachu, and A. T. Lytviak.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 115-121, 7 fig, 1 tab, 6 ref.

Descriptors: *Model studies, *Underground waste disposal, *Injection wells, *Disposal wells, *Geohydrology, *Waste management, *Waste disposal, *Aquifers, Economic aspects, Mathematical models, Simulation analysis, Stratigraphy, Groundwater, Flow, Alberta, Canada.

A detailed hydrogeological study was carried out in a region defined as Tp 62-74, R 1-13, W5 Mer in north central Alberta, comprising 15,760 sq km effectively centered on the Special Waste Injection Site of the Alberta Special Waste Management Corp. The objective was the selection of aquifers for environmentally safe disposal of mine wastes. The 9-step approach included (1) identification of the major hydrogeological and economic constraints, (2) an analysis of the natural flow system for all hydrostratigraphic units between the Lower Cretaceous Viking Sandstone Aquifer and the Precambrian basement, (3) numerical simulation of the flow in effectively the entire Phanerozoic sequence to obtain conformance with the natural flow system, and (4) perturbation of the numerical model at an injection rate of 225 cu m/d in two potential injection aquifers to test the degree of confinement of the pressure build-up. The study was based on examination and interpretation of stratigraphic information from 3,276 wells, 635 drillstem tests, 3,477 core analyses, and 645 formation water analyses from the files of the Energy Resources Conservation Board, using specialized software developed by the Basin Analysis Group, and the three-dimensional finite element ground water model FE3DGW. The preferred injection unit is the basal portion of the Wabamun-Winterburn Aquifer, with the Basal Cambrian Sandstone as a less-desirable back-up injection aquifer. (See also W89-01661) (Author's abstract)
W89-01673

COMPARISON OF LANDFILL DESIGN ALTERNATIVES BASED ON GROUND WATER FLOW MODELING,
Gartner Lee Associates Ltd., Markham (Ontario).
R. G. McLaren, S. C. Hollingshead, and K. G. Kennedy.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 171-175, 8 fig, 1 tab, 14 ref.

Descriptors: *Landfills, *Aquifers, *Groundwater movement, *Model studies, *Geohydrology, Finite element method, Computer models, Water table, Comparison studies, Spring water, Seep water, Leachates, Environmental protection.

Hydrogeologic performance must be considered a key aspect of engineered landfill design in order to maximize environmental protection. A two-dimensional finite-element computer model was used to generically compare impacts of the ground water flow system for three landfill design configurations: above-ground, shallow entombed and conventional. Site conditions that were simulated consisted of thick, fine-grained soil deposits underlain by an aquifer. Baseline hydrogeology was established by modeling the initial site conditions until good agreement was reached with hydrogeologic field studies of similar sites in southwestern Ontario. Each of the three landfill configurations was superimposed on the baseline model. Ground water flow was predicted according to potential water table conditions in the landfill, in both the passive and active operational mode. The use of an active leachate collection system allows the water table in any of the three design configurations to be manipulated. Reduced hydraulic head in the landfill minimizes the impact on the surrounding ground water flow system. However, in the passive mode or in the long-term when active leachate collection systems may not be relied upon, the shallow entombed configuration produced the least flow of leachate from the landfill. The shallow entombed alternative also demonstrated the least tendency to produce leachate springs or seeps at the landfill surface. In all cases the cover system proved a key design element since it directly affected the rate of leachate generation. These results demonstrate that this method of analysis is an effective technique for site-specific landfill design which can provide valuable guidelines to design engineers. (See also W89-01661) (Author's abstract)

W89-01680

STATUS REPORT: THE USE OF ENGINEERED COVERS AT WASTE DISPOSAL SITES,
Golder Associates, Mississauga (Ontario).
T. A. Mclelwain, and D. W. Reades.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 176-182, 7 fig, 4 ref. Environment Canada DSS Contract 52SS. KE 145-4-0341.

Descriptors: *Waste disposal, *Waste management, *Underground waste disposal, *Environmental engineering, Covers, Design, Construction, Performance evaluation, Hazardous materials.

A recent study commissioned by the Waste Management Branch of Environment Canada has evaluated the current state-of-the-art in the field of engineered final cover systems at North American and western European waste management facilities. Details of design, construction and performance monitoring at specific waste management sites, where specially engineered final cover systems have been installed, were solicited by means of an industry user questionnaire sent to more than 100 contacts active in the waste management field. The study findings are illustrated by means of field examples of cover applications installed over various types of waste in various environments and designed to meet site-specific criteria. Based on the information collected, it appears that covers made of compacted natural materials alone are inadequate in the long term, whereas covers using augmented soils or synthetic membranes show the greatest potential for widespread use based on observed performance. Reported failure mechanisms associated with evolving design requirements of cover applications to meet specific objectives are being investigated at numerous government, industry and academic institutions. The recent study findings have identified specific aspects of engineered cover design, construction and performance monitoring that would benefit from additional research. (See also W89-01661) (Author's abstract)
W89-01681

EVALUATING THE EFFECTIVENESS OF AN ASPHALT CAP AT A SUPERFUND SITE,
JRB Associates, Inc., McLean, VA. Ground Water Section.
E. W. Repa.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 183-191, 3 fig, 6 tab, 10 ref. Environmental Protection Agency Contract 68-03-3113, Work Assignment No. 39-5.

Descriptors: *Waste disposal, *Materials, *Waste management, *Environmental engineering, *Underground waste disposal, Asphalt caps, Design, Construction, Performance evaluation, Hazardous materials.

An asphalt concrete cap was installed on a portion of a Superfund site as a temporary remedial action to reduce the amount of precipitation contacting the contaminated portions of the site and subsequently running off or infiltrating through the surface. To determine the effectiveness of the cap in achieving these objectives, asphalt cores were taken from selected areas to be tested to determine their permeability and percent air voids. These data were compared to published values of permeability and percent air voids for hydraulic asphalt concretes. Study results showed that the cap did not achieve the desired objectives of the remedial action. The emplaced asphalt cap was found to be highly permeable (.14 cm/sec), permeabilities were consistent across the cap regardless of sampling location (mats versus joints), and permeabilities were directly related to percent air voids. In order to effectively install an impermeable asphalt concrete cap, the following design and construction criteria are recommended: (1) maintaining asphalt content between 6-9.5%, (2) maintaining mineral filler content between 8-13%, (3) matching coarser aggregates to compacted depth to ensure proper compaction without bridging of the aggregate, (4) compacting the asphalt concrete to 4% or less air voids, (5) preparing a proper subgrade to drain the water under the pavement and provide a stable foundation, (6) sloping the joint edges at a 1:1 slope to ensure proper compaction, (7) applying a tack coat to joint edges to ensure bonding, (8) sealing the surface with an asphalt sealer, and (9) preparing test samples for laboratory and field testing. (See also W89-01661) (Author's abstract)
W89-01682

GROUND WATER CONTAMINATION ASSOCIATED WITH WASTE DISPOSAL INTO A WATER-FILLED OPEN-PIT COAL MINE,
Alberta Environment, Edmonton.
For primary bibliographic entry see Field 5B.
W89-01683

RISK ASSESSMENT OF DEEP WELL INJECTION SYSTEMS,
Underground Resource Management, Inc., Austin, TX.
R. T. Kent, and M. E. Bentley.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 233-242, 1 fig, 37 ref.

Descriptors: *Disposal wells, *Path of pollutants, *Injection wells, *Underground waste disposal, *Liquid wastes, *Industrial wastes, *Groundwater pollution, Contamination, Risk assessment, Hazardous materials.

Injection wells have been used to dispose of liquid wastes for more than 50 years. In 1984 there were more than 450 industrial waste disposal wells in the U.S. Thousands of additional injection wells dispose of brine produced in association with oil or gas. As part of the current national reevaluation of the viability of injection wells, past failures should be reassessed to determine the adequacy of current technology and regulation to prevent their recurrence. Although a significant body of literature exists concerning the engineering of injection well systems, little has been published concerning the technical or geologic aspects of injection well failures. This paper gives several examples of each of the primary types of failures that have occurred in the past. The case histories reviewed include wells located in Ontario, Pennsylvania, Colorado, Texas, Alabama, Ohio, Florida and New York. Failure occurrences generally fall into 5 categories. These are: (1) leakage from the well; (2) upward migration through nearby wellbores; (3) upward migration through channels in the cement adjacent to the casing or wellbore of the injection well; (4) upward migration through faults or fractures; and (5) generation of seismic activity. Many failures have not led to contamination of the environment. This lack of contamination was, in many instances, due as much to fortuitous geologic conditions as to design criteria. The experience learned from these case histories, however, can be used to develop safer siting, design, and operating programs for injection wells. (See also W89-01661) (Author's abstract)
W89-01688

DEEP-WELL DISPOSAL FORMATIONS, A VALUABLE RESOURCE,
Williams Bros. Engineering Co., Tulsa, OK.
R. W. Amstutz.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 243-246, 2 fig, 2 ref.

Descriptors: *Injection wells, *Underground waste disposal, *Liquid wastes, *Disposal wells, *Industrial wastes, *Chemical industry, *Oil industry, Hazardous materials, Operating costs, Well regulations.

Some geological formations have the required characteristics for safe, permanent storage of liquid hazardous wastes. They are effectively sealed and separated from the overlying shallow fresh waters. Disposal of oil-field brines into deep wells for the past 50-60 years was a good concept but it often was carelessly carried out causing considerable environmental damage. Industrial disposal wells installed today, in compliance with EPA and state regulations, pose almost zero risk to the environment. There were 195 active Class I wells in operation in 1984, 2/3 of them in Texas and Louisiana. Approximately 1/2 of the wastes is from manufacturers of organic chemicals and 1/4 from petroleum refiners. There are 15 characteristics which are needed for the ideal disposal formation. The Arbuckle Formation in Oklahoma and some surrounding states is one of the formations that has all of these criteria. Installation costs of approved disposal well systems may cost $500,000 to $1,500,000 or more. Operating costs for large systems are in the range of 0.2 cents per gallon (.05 cents per liter) or more. Three decades of relatively safe experience in deep-well injection compared with the poor record of lagoons, landfills, dumps and ponds confirms that careful injection into Class I wells is an appropriate procedure for permanent disposal of hazardous liquid wastes. (See also W89-01661) (Author's abstract)
W89-01689

EVALUATION OF HAZARDOUS LIQUID WASTE DISPOSAL,
Illinois State Geological Survey Div., Champaign.
R. D. Brower, I. Krapac, B. R. Hensel, A. P. Visocky, and G. R. Peyton.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 247-254, 8 fig, 8 ref.

Descriptors: *Injection wells, *Underground waste disposal, *Liquid wastes, *Industrial wastes, *Contamination, Well regulations, Hazardous materials, Surface runoff, Monitoring, Illinois.

Illinois currently has 9 Class I injection wells at 7 industrial sites, where liquid industrial wastes are injected into geologic formations at depths ranging from 470 to 1683 m (1540 to 5524 ft). This disposal practice began 20 years ago. The Illinois State Legislature recently mandated an evaluation of the adequacy of the Underground Injection Control (UIC) program. The Illinois State Geological Survey and the Illinois State Water Survey are assessing: (1) current regulations and regulatory practices for Class I wells, (2) amount and chemical character of the injected wastes, (3) construction and monitoring practices of disposal well facilities, (4) geologic settings of deep-well injection, (5) environmental and economic impacts of alternative disposal options. Injection of industrial wastes in Illinois totals approximately 1.1 million cu m (300 million U.S. gallons) annually. The chemical character of these wastes is quite diverse, ranging from very alkaline chlorinated organics with pH of 13 to acidic inorganic salts with pH of <2. Contaminated surface runoff from plant facilities represents a significant fraction of the injected waste volume. Historically, there have been few operational difficulties with most of these wells and any losses from disposal systems have been limited to minor leakages upstream from well heads. Recently adopted regulations, coupled with increasing interest in more comprehensive monitoring of all phases of hazardous waste disposal, are requiring careful evaluation of all aspects of deep-well disposal of these wastes. This may necessitate upgrading of regulatory practices to meet the intent of the regulations, particularly in certain areas of monitoring. (See also W89-01661) (Author's abstract)
W89-01690

USE OF BIOASSAY AND ASSOCIATED TESTS IN DREDGED MATERIAL AND DISPOSAL MANAGEMENT,
Corps of Engineers, Vicksburg, MS.
For primary bibliographic entry see Field 5B.
W89-01722

ECOLOGICAL CONSIDERATIONS IN WETLANDS TREATMENT OF MUNICIPAL WASTEWATERS.
For primary bibliographic entry see Field 5D.
W89-01827

WETLAND SYSTEMS FOR WASTEWATER TREATMENT: ENGINEERING APPLICATIONS,
Ramlit Associates, Inc., Berkeley, CA.
For primary bibliographic entry see Field 5D.
W89-01828

DESIGN AND USE OF ARTIFICIAL WETLANDS,
Ontario Ministry of the Environment, Toronto. Policy and Planning Branch.
For primary bibliographic entry see Field 2H.
W89-01829

MOSQUITO CONSIDERATIONS IN THE DESIGN OF WETLAND SYSTEMS FOR THE TREATMENT OF WASTEWATER,
Dewante and Stowell, Sacramento, CA.
For primary bibliographic entry see Field 5D.
W89-01830

CONSIDERATIONS FOR WETLAND TREATMENT OF SPENT GEOTHERMAL FLUIDS,
CH2M, Inc., Portland, OR.
For primary bibliographic entry see Field 5D.
W89-01831

ENERGY FLOW IN WETLANDS,
Massachusetts Univ., Amherst. Dept. of Forestry and Wildlife Management.
For primary bibliographic entry see Field 5D.
W89-01834

WASTEWATER INPUT TO COASTAL WETLANDS: MANAGEMENT CONCERNS,
San Diego State Univ., CA. Dept. of Biology.
For primary bibliographic entry see Field 5D.
W89-01835

COMPARISONS OF THE PROCESSING OF ELEMENTS BY ECOSYSTEMS, I: NUTRIENTS,
Cornell Univ., Ithaca, NY. Ecosystems Research Center.
For primary bibliographic entry see Field 2H.
W89-01836

EFFECT OF NATURAL HYDROPERIOD FLUCTUATIONS ON FRESHWATER WETLANDS RECEIVING ADDED NUTRIENTS,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5D.
W89-01838

SIGNIFICANCE OF HYDROLOGY TO WETLAND NUTRIENT PROCESSING,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-01839

TERRESTRIAL COMMUNITIES: FROM MESIC TO HYDRIC,
Bowling Green State Univ., OH. Dept. of Biological Sciences.
W. B. Jackson.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 224-230, 1 tab, 21 ref.

Descriptors: *Wetlands, *Wetlands treatment, *Water pollution effects, *Wastewater disposal, *Land disposal, Ecological effects, Ecosystems, Coliforms, Birds, Mammals, Foreests, Peat bags, Wastewater irrigation, Viruses.

Changes in animal and plant communities in four areas used for wastewater effluent disposal are described. Two of the disposable areas were woodland sites; in the third case, clarified effluent was used for crop irrigation and the fourth case used peatland for effluent disposal. The potential for biomagnification through the animal community remains a concern of unknown dimensions. Both birds and small mammals are known reservoirs for several of the viral encephalitides. Enteric organisms are of obvious concern. However, in the peatland project, the peatland itself contained moderate levels of nonfood coliforms, and it was decided that no chlorination of the effluent was necessary. In a decade-long study of one small woodlot, soil moisture levels in the spring and late summer were especially critical for seed germination and seedling survival, respectively. Interactions with soil type, soil chemistry, and topography also occurred. Consequently, the composition of the herbaceous community and the availability of woody seedlings could shift dramatically, and a single series of quadrat data could result in a nonrepresentative assessment of the community. Enrichment and enhancement of these environments may have other impacts. Usually focuses of efforts are on 'damaged' ecosystems, on subclimax or disclimax communities, on cut-over or scrub environments. Even so, community structure is present, and environmental inputs will influence those communities and ecosystems. Even though a 'degraded' environment may be affected, the objective can be enhancement rather than further degradation or increasing environmental hazard. (See also W89-01827) (Lantz-PTT)
W89-01841

VEGETATION IN WETLANDS RECEIVING SEWAGE EFFLUENT: THE IMPORTANCE OF THE SEED BANK,
Smithsonian Environmental Research Center, Edgewater, MD.
For primary bibliographic entry see Field 5D.
W89-01842

PUBLIC HEALTH IMPLICATIONS OF SEWAGE APPLICATIONS ON WETLANDS: MICROBIOLOGICAL ASPECTS,
Massachusetts Univ. at Boston. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W89-01843

WILDLIFE HEALTH IMPLICATIONS OF SEWAGE DISPOSAL IN WETLANDS,
National Wildlife Health Lab., Madison, WI.
M. Friend.
IN: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Company, New York. 1985. p 262-269, 21 ref.

Descriptors: *Environmental impact, *Wetlands treatment, *Wildlife, *Wastewater disposal, *Wetlands, *Pathogens, Water pollution effects, Environmental effects, Chemical properties, Physical properties, Animal diseases, Marshes.

Wildlife health concerns associated with disposal of sewage effluent in wetlands are of three primary types: (1) introduction of pathogens, (2) introduction of pollutants that adversely impact on host body defense mechanisms, and (3) changes in the physical and chemical properties of wetlands that favor the development and maintenance of disease problems. Unlike the situation with human health concerns, introduction of pathogens is not the major concern regarding wildlife health. Instead, the focus of attention needs to be directed at environmental changes likely to take place as a result of effluent discharges into different types of wetlands. Unless these changes are adequately addressed from a disease perspective, marshes utilized for sewage disposal could become disease incubators and wildlife death traps. This result would be unfortunate because the backlash would likely negate the potentially beneficial aspects of the use of sewage wastewater for the creation of new wetlands and have a severe impact on progress being made towards evaluation of the compatibility of wildlife and sewage effluents. (See also W89-01827) (Lantz-PTT)
W89-01844

MICROBIOLOGICAL STUDIES OF MUNICIPAL WASTE RELEASE TO AQUATIC ENVIRONMENTS,
Maryland Univ., College Park. Dept. of Microbiology.
For primary bibliographic entry see Field 5D.
W89-01845

MICROBIAL TRANSFORMATIONS OF DETRITAL CARBON IN WETLAND ECOSYSTEMS: EFFECTS OF ENVIRONMENTAL STRESS,
Georgia Univ., Athens. Dept. of Microbiology.
For primary bibliographic entry see Field 5D.
W89-01846

AGING PHENOMENA IN WASTEWATER WETLANDS,
Michigan Univ., Ann Arbor. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W89-01850

ECOLOGICAL EVALUATION PROCEDURE FOR DETERMINING WETLAND SUITABILITY FOR WASTEWATER TREATMENT AND DISCHARGES,
Southeast Wisconsin Regional Planning Commission, Waukesha.
For primary bibliographic entry see Field 5D.
W89-01852

MANAGEMENT POTENTIAL FOR NUTRIENT REMOVAL IN FORESTED WETLANDS,
East Carolina Univ., Greenville, NC. Dept. of Biology.
For primary bibliographic entry see Field 5D.
W89-01853

WETLAND-WASTEWATER ECONOMICS,
Williams and Works, Grand Rapids, MI.
For primary bibliographic entry see Field 5D.
W89-01854

COMPARATIVE TOXICITY OF WHOLE AND LIQUID PHASE SEWAGE SLUDGES TO MARINE ORGANISMS,
EA Engineering, Science, and Technology, Inc., Sparks, MD.
For primary bibliographic entry see Field 5C.
W89-01945

APPROACH TO SEWAGE SLUDGE BIOACCUMULATION POTENTIAL TESTS,
Ecological Analysts, Inc., Sparks, MD.
For primary bibliographic entry see Field 5C.
W89-01946

STATISTICAL TEST PROCEDURE FOR EFFLUENT TOXICITY SCREENING,
SCI Data Systems, Inc., Annapolis, MD.
For primary bibliographic entry see Field 5A.
W89-01949

ISOLATION AND CHEMICAL CHARACTERIZATION OF PETROLEUM REFINERY WASTEWATER FRACTIONS ACUTELY LETHAL TO DAPHNIA MAGNA,
Enwright Labs., Greenville, SC.
For primary bibliographic entry see Field 5A.
W89-01950

IMPLICATIONS OF WASTE DISPOSAL IN COASTAL WATERS ON FISH POPULATIONS,
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
For primary bibliographic entry see Field 5C.
W89-01954

PROCEEDINGS OF THE 42ND INDUSTRIAL WASTE CONFERENCE.
For primary bibliographic entry see Field 5D.
W89-02006

IMPLEMENTATION AND ENFORCEMENT OF AN INDUSTRIAL WASTE PRETREATMENT PROGRAM IN ORLANDO, FLORIDA,
Orlando, FL.
For primary bibliographic entry see Field 5D.
W89-02008

COST ALLOCATION AT SUPERFUND SITES,
Environmental Resources Management-North Central, Inc., Deerfield, IL.
For primary bibliographic entry see Field 5G.
W89-02009

COOPERATIVE EFFORT TO REMEDIATE A HISTORICAL PCB DISPOSAL SITE,
Aluminum Co. of America, Davenport, IA. Davenport Works.
For primary bibliographic entry see Field 5G.
W89-02010

MANUFACTURED GAS WASTE DISPOSAL INVESTIGATIONS. TWO CASE STUDIES IN IOWA,
Wisconsin Dept. of Natural Resources, Madison.
For primary bibliographic entry see Field 5B.
W89-02011

STABILIZATION OF A THERMALLY SENSITIVE NITRO-COMPOUND WASTE,
Air Products and Chemicals, Inc., Allentown, PA. Chemicals Div.
K. B. Adams.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 75-84, 6 fig, 5 tab, 7 ref.

Descriptors: *Wastewater treatment, *Stabilization, *Hazardous wastes, *Nitrogen compounds, *Waste disposal, Landfills, Regulations, Pilot plants.

A stabilization process for thermally sensitive nitro-compound wastes was developed and optimized satisfying the initial disposal criteria of: (1) an irreversible chemical reaction of the free-liquid water; (2) a stabilization recipe which allowed processing in conventional solids blending equipment; and (3) a stabilized waste product with the physical and chemical characteristics satisfying regulatory agency and landfill operator disposal qualifications. Thermal analysis techniques identified the increased decomposition sensitivity of alkali-stabilized wastes. Small scale laboratory experiments effectively predicted the exotherms of stabilization reactions and established stabilization agent specifications to mitigate excessive temperature rise. Pilot testing was critical in refining the stabilization recipe to meet processing limitations of commercial scale equipment. The result was a safe and effective stabilization process to remove and dispose thermally sensitive waste and permit ultimate closure of the Resource Conservation a Recovery Act surface impoundment. (See also W89-02006) (Lantz-PTT)
W89-02014

IMPROVING STABILITY OF A PAPER MILL SLUDGE,
Wisconsin Dept. of Natural Resources, Madison.
For primary bibliographic entry see Field 5D.
W89-02021

USE OF CHRONIC BIOASSAYS FOR PULP AND PAPER MILL EFFLUENTS IN WISCONSIN,
Wisconsin Dept. of Natural Resources, Madison.
For primary bibliographic entry see Field 5A.
W89-02031

DEVELOPMENT OF TREATMENT ALTERNATIVES THROUGH AN UNDERSTANDING OF WASTE CHEMISTRY,
RECRA Environmental, Inc., Amherst, NY.
For primary bibliographic entry see Field 5D.
W89-02036

WASTE REDUCTION IN ILLINOIS: AN OVERVIEW,
Illinois State Water Survey Div., Savoy. Hazardous Waste Research and Information Center.
For primary bibliographic entry see Field 5G.
W89-02037

STUDY AND IMPLEMENTATION OF WASTE MINIMIZATION AT IBM AUSTIN,
Montgomery (James M.), Inc., Pasadena, CA.
D. R. Wilkes, and M. K. Young.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 331-340, 5 fig, 7 ref.

Descriptors: *Waste management, *Waste minimization, *Waste disposal, *Wastewater treatment, Waste reductions, Sludge, Recycling, Separation processes, Hazardous wastes, Austin, Texas, Process water, Electronics industry.

IBM contracted, in the fall of 1985, for a study to evaluate all of the waste-producing processes at its Austin, Texas, facility for potential ways to improve waste management, principally through waste reduction. The objective of this effort centered around a comprehensive and thorough evaluation of alternative waste management procedures for each waste streams, motivated by potential savings on waste management costs but also the reduction of liability at disposal sites. The processes at the plant generate a variety of hazardous and nonhazardous wastes. In terms of volume, the largest category of wastes is process wastewater. Another large volume waste is wastewater treatment sludge generated from the onsite facility. Other types of wastes include spent solvents, used oil, scrap copper, laboratory wastes, soldering residues, and dilute organic wastewaters. Waste management methods range from onsite solvent recovery to offsite incineration. Onsite treatment is used for the majority of the high volume liquid hazardous waste streams. For both hazardous and nonhazardous drummed wastes, the predominant method is offsite disposal followed by offsite reclamation/recycle. The major finding of the study are: (1) source reduction measures including general housekeeping changes, waste segregation and/or compaction and waste storage container reuse produced the greatest potential savings; (2) The wastes most amenable to minimization were large multiple component solid waste streams; and (3) Five of the 27 process areas accounted for over 90% of the projected savings. Additional conclusions from the study included implementation steps recommended as a result of observations during the individual waste stream evaluations. These steps are: (1) program management; (2) education and training; (3) waste-specific accounting; and (4) coordination of further investigation. (See also W89-02006) (Lantz-PTT)
W89-02038

REGULATION OF TOXIC ORGANICS IN INDUSTRIAL SEWER DISCHARGES AT THE SANITATION DISTRICTS OF LOS ANGELES COUNTY,
Los Angeles County Sanitation Districts, Whittier, CA.
J. G. Kremer, M. P. Lo, P. C. Martyn, and L. S. Directo.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 347-371, 13 fig, 13 tab.

Descriptors: *Toxic wastes, *Wastewater treatment, *Wastewater disposal, *Landfills, *Organic compounds, *Los Angeles, *Toxicity, *Water pollution control, *California, Municipal wastewater, Heavy metals, Cyanide, Landfills.

Regulation of heavy metals and traditional pollutants is being accomplished fairly well under EPA and various local pretreatment programs. At the Sanitation Districts of Los Angeles County, significant removals of traditional heavy metal and cyanide pollutants have occurred. Implementation of heavy metal regulations has proceeded smoothly to control this source of industrial pollution. Problems which were anticipated from heavy metals may also have been overstated. In a large sewerage system, most heavy metals enter the treatment plant as inert solids combined with sulfides. Problems with leaching of heavy metals from landfills may also not be as widespread as believed. Landfill leachates in many southern California areas contain little or no heavy metals. The area of pollution control which is now evolving is that of toxic organic pollutants. There is significant concern by the residents of local sewerage agencies of long-term, detrimental effects from toxic organics. At the Sanitation Districts of Los Angeles County, short-term sewerage system problems were created by organic pollutants prior to the current citizen concerns about these pollutants. In the organic pollutant area, there is an extremely large number of compounds which can create a span of problems wider than that encountered with traditional heavy metal pollutants. These problems can include air pollution, sewer clogging, personnel toxicity, treatment process upset and explosion hazards. It is concluded that the traditional emphasis of the industrial waste control programs on pollutants such as heavy metals and cyanides, etc., may now be evolving into a more positive control of toxic organic materials. As this evolution occurs, the complexity of local industrial waste regulatory efforts will increase. The identification and evaluation of the numerous toxic organic compounds and their proper control will require more involved industrial waste control technology by the local sewerage agency. (See also W89-02006) (Lantz-PTT)
W89-02040

COMMUNITY INVOLVEMENT: THE CATALYTIC FACTOR IN WASTE MANAGEMENT,
Winsor Associates, Ardmore, PA.
For primary bibliographic entry see Field 6E.
W89-02041

INTEGRATED PLANT FOR TREATMENT OF DILUTE HAZARDOUS WASTE,
Aerojet Corp., Sacramento, CA.
For primary bibliographic entry see Field 5D.
W89-02042

GEOSYNTHETICS FOR USE IN WASTE FACILITIES,
S and ME, Inc., Fairfield, OH.
For primary bibliographic entry see Field 5G.
W89-02043

CHARACTERIZATION OF TREATMENT RESIDUES FROM HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES,
Metcalf and Eddy, Inc., Wakefield, MA.
For primary bibliographic entry see Field 5D.
W89-02045

ACCELERATED AGING OF HIGH DENSITY POLYETHYLENE GEOMEMBRANES: A NOVEL APPROACH,
Gundle Lining Systems, Inc., Houston, TX.
M. W. Cadwallader.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 419-428, 7 fig, 3 tab, 18 ref.

Descriptors: *Material engineering, *Material testing, *Water pollution prevention, *Linings, *Waste disposal, *Geomembranes, *Polyethylene, Performance evaluation, Polymers, Temperature, Chemical analysis, Degradation.

Results of a thermal-oxidative degradation study indicate that not all high density polyethylene (HDP) liners age the same. The factors which impact liner stability are probably not so much a function of polymer variety as they are of quality product design and manufacture. This is not the case in, for instance, chemical resistance testing where as long as polymer variety is correct, results appear satisfactory. HDPE seems to be more or

less HDPE in chemical resistance testing. But for thermal-oxidative degradation, nuances in product design and manufacture such as resin quality, production heat history, and antioxidant package introduce large performance differences among HDPE liners. For testing the thermal-oxidative stability of HDPE liners, the procedure presented in this study works very well. The procedure is fast, the endpoint to the test is well defined, and results are reproducible. A test can be run easily at 130 C, which is not much higher than the 110 C frequently used in over aging tests. The test relates well to actual liner property performance since consumption of oxygen by thermal-oxidative degradation has been correlated to loss of polymer elongation. To answer the question, 'How long will the liner last', a thorough picture of liner life-expectancy must be considered. Ultraviolet light stability, chemical resistance, and environmental stress crack resistance, in addition to thermal-oxidative stability, all must be taken into account. When this is done, HDPE geomembrane liners may last a very long time. (See also W89-02006) (Lantz-PTT)
W89-02046

SPENT CAUSTIC TREATMENT AND DISPOSAL,
Stone and Webster Engineering Corp., Boston, MA.
For primary bibliographic entry see Field 5D.
W89-02047

IRRIGATION OF PASTURE WITH MEAT-PROCESSING PLANT EFFLUENT,
Meat Industry Research Inst. of New Zealand, Hamilton.
J. M. Russell, and R. N. Cooper.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 491-497, 1 fig, 7 tab, 23 ref.

Descriptors: *Wastewater irrigation, *Meat processing industry, *Wastewater disposal, Industrial wastewater, Nitrates, Nitrogen, Toxicity, Groundwater pollution, Fertilization.

Irrigation with primary-treated meat-processing plant effluent increased pasture production at all nitrogen loadings tested (up to 2800 kg N/ha/yr). However, nitrate-nitrogen levels in the harvested grass also increased and reach reported toxic levels at loadings between 1200 and 2600 kg N/ha/yr. Suitable animal feeding regimes should decrease the toxicity of the pasture even at these loadings. Losses of nitrate-nitrogen to the groundwater increased with nitrogen loading. The losses were approximately 100-170 kg NO3-N/ha/yr at nitrogen loadings of 440-600 kg N/ha/yr, 310-330 kg NO3-N/ha/yr at loadings of 890-1220 N/ha/yr and as high as 1725 kg NO3-N/ha/yr at a nitrogen loading of 2440 kg N/ha/yr. The resulting nitrate-nitrogen concentration that will enter the groundwater from any site can be calculated from these losses and the rainfall, effluent volume and evapotranspiration data for the site. In this way a nitrogen loading that will produce an effect similar to other land uses in the area and will not affect other groundwater users can be derived. Meat-processing effluent is a natural balanced fertilizer and does not contain toxic substances. So long as due regard is given to groundwater protection and animal health, this effluent can be safely used for irrigation purposes. (See also W89-02006) (Lantz-PTT)
W89-02055

WISCONSIN GROUNDWATER QUALITY STANDARDS: CAN WASTEWATER LAND TREATMENT SYSTEMS MEET THEM,
Wisconsin Dept. of Natural Resources, Madison. Div. of Environmental Standards.
For primary bibliographic entry see Field 6E.
W89-02080

SCOPE OF THE PROBLEM,
Consultants in Environmental Sciences Ltd., London (England).
For primary bibliographic entry see Field 5C.
W89-02098

HEAVY METALS IN WASTEWATER AND SLUDGE TREATMENT PROCESSES. VOLUME II: TREATMENT AND DISPOSAL.
CRC Press, Inc., Boca Raton, Florida, 1987. 155p. Edited by John N. Lester.

Descriptors: *Sludge, *Water pollution control, *Wastewater disposal, *Wastewater treatment, *Heavy metals, Activated sludge processes, Adsorption, Biodegradation, Sludge disposal, Ocean dumping, Water quality control.

In the second of two volumes on heavy metals in wastewater and sludge attention is focussed on treatment and disposal. The six chapters cover the following topics: (1) primary mechanical treatment; (2) biological treatment; (3) sludge treatment; (4) water treatment and reuse; (5) sludge disposal to land; and (6) sludge disposal to sea. (See W89-02105 thru W89-02110; W89-02097)
W89-02104

SLUDGE DISPOSAL TO LAND,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
D. L. Lake.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume II: Treatment and Disposal. CRC Press, Inc., Boca Raton, Florida, 1987. p 91-130, 9 tab, 245 ref.

Descriptors: *Sludge disposal, *Land disposal, *Wastewater disposal, *Heavy metals, Agriculture, Calcium, Chromium, Copper, Nickel, Lead, Zinc, Speciation, Economic aspects, Ocean dumping, Landfills.

Treatment and disposal of large quantities of sewage sludge account for approximately 50% of the total cost of sewage treatment in the U.K. or about 200 pounds sterling/yr. Since raw sludges contain between 1 and 7% solids which are usually highly putrescible and offensive, they are frequently treated to produce more stable and less offensive sludges of reduced mass and pathogenic content, thus facilitating their ultimate disposal. Sludge disposal options are limited by economic constraints, primarily imposed by the rapid increased in the cost of energy. In addition, sludge disposal of and the relatively high levels of some pollutants which become concentrated in the sludge during wastewater treatment. 67% of the total sludge produced in the U.K. is disposed of to land, with 41% being applied to agricultural land and the remainder being used principally as landfill and for land reclamation. Of the remaining sludge, 29% is dumped at sea, while only 4% is incinerated. In 1982, the major U.S. sludge disposal routes were reported to be land application (31%), landfill (24%), incineration (21%), ocean dumping (18%), and composting (1%). Disposal to agricultural land is not likely to decrease in the near future because of restrictions on alternative practices; the use of landfill, for example, may be severely restricted by the cost and availability of sites. The disposal of sewage sludge to agricultural land may have beneficial effects by adding plant nutrients such as nitrogen, phosphorus, and essential trace elements. In addition, the organic matter in sludge is of value in the maintenance of long term soil structure and fertility. Since only about 1% of the total flow of sewage to a works is produced as sludge, and this typically contains more than 50 to 80% of the total quantity of heavy metals entering the works, the metals are concentrated to a significant degree. It has been estimated that approximately 8000 tons of the six heavy metals Cd, Cr, Cu, Ni, Pb, and Zn are annually incorporated into sludges in the U.K. This chapter relates the behavior and environmental impact of heavy metals present in sewage sludge to disposal of this sludge to agricultural land. In particular, the importance of the physical and chemical speciation of these metals in hazard assessment is discussed. (See also W89-02104) (Lantz-PTT)
W89-02109

SLUDGE DISPOSAL TO SEA,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
P. W. W. Kirk.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume II: Treatment and Disposal. CRC Press, Inc., Boca Raton, Florida, 1987. p 131-144, 6 tab, 144 ref.

Descriptors: *Ocean dumping, *Sludge disposal, *Waste disposal, Environmental effects, Water pollution sources, Marine environment, Water pollution effects.

The behavior of heavy metals following sludge disposal to sea has received relatively little attention, with expenditure in the U.K. being directed towards the monitoring of disposal sites by the Ministry of Agriculture, Fisheries, and Food (MAFF) in accordance with their statutory responsibilities, in preference to more fundamental research which would be required to gain an appreciation of the ultimate fate of heavy metals discharged to the marine environment. However, the limited information available may suggest that some mobilization of heavy metals occurs as a result of the redistribution of metals from largely insoluble forms in sludges to soluble metalloorganic complexes, inorganic complexes, and the free metal ion, with subsequent effects on bioavailability. One study concluded that the concentrations of heavy metals in estuarine sediments do not necessarily reflect the biological availability of sediment-bound metals to benthic organisms, although the metal distribution in the particulate size fractions of the sediment and the mechanism of metal binding to the particulates were instrumental in determining metal availability. It is generally accepted that there is insufficient evidence presently available to demonstrate that there are no harmful or unacceptable effects resulting from sludge disposal to sea, particularly with regard to adverse effects on marine biota and bioaccumulation. Present defensive research and monitoring work on dumping at sea is inadequate in relation to the scale of this disposal practice. (See also W89-02104) (Lantz-PTT)
W89-02110

DISPOSAL ACTIVITIES AS A SOURCE OF CONTAMINANTS TO LARGE LAKES,
Waterloo Univ. (Ontario).
For primary bibliographic entry see Field 5B.
W89-02160

INTEGRATED WASTE MANAGEMENT: AN INDUSTRIAL PERSPECTIVE,
Dow Chemical Co., Midland, MI.
D. W. Calvin, J. M. Rio, and B. L. Haviland.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 165-175, 3 fig.

Descriptors: *Chemical industry, *Waste management, *Waste disposal, *Wastewater treatment, Environmental protection, Reclamation, Landfills, Incineration, Water pollution prevention, Industrial wastewater, Industrial water, Cooling water.

The Midland, Michigan manufacturing site of The Dow Chemical Company, has become the company's specialty chemical production headquarters. More than 500 different products are currently produced from this 375 ha site. Vital to the operation of the Midland plant is the Tittabawassee River. This river runs through the heart of the plant. It is a tributary of the Saginaw River, which empties into Saginaw Bay of Lake Huron at Bay City, Michigan. The Tittabawassee River is not a large river, but Dow borrows a significant quantity of water from the river for process and reactor cooling purposes. This water, along with Dow's treated wastewater, is returned to the river. This situation, a large chemical complex built adjacent to a relatively small body of water, has made the Midland plant site an environmental management challenge for many years. Dow recognized the need for effective waste treatment as early as the 1930s. The company installed a set of 'trickling filters' then, and also operated a waste incinerator.

Later, in 1948, Dow developed and operated the world's first rotary kiln for the destruction of chemical wastes. In addition to waste treatment, in 1930 the company also established its toxicology laboratories in Midland to study the effects of the company's products on the environment and human health. These pioneering efforts have contributed to the recognition of Dow as a leader in the fields of toxicology and epidemiology. Waste management alternatives explored at Dow included: elimination, reclamation, treatment and destruction, secure landfill, incineration, and wastewater treatment. Dow's Midland plant site experience demonstrates the ability for industry to co-exist with the environment, even under difficult geographical and political conditions. The company recognizes the need for good environmental stewardship and intends to demonstrate continued dedication to this cause, not just to its satisfaction, but the satisfaction of a better informed public. (See also W89-02155) (Lantz-PTT)
W89-02165

MANAGEMENT OF RESIDUES FROM CENTRALIZED HAZARDOUS WASTE TREATMENT FACILITIES,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
S. E. Hrudey, and K. J. Simpson.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 177-190, 1 fig, 10 ref.

Descriptors: *Waste management, *Hazardous wastes, *Waste treatment, *Waste disposal, *Alberta, *Canada, Neutralization, Oxidation, Chemical precipitation, Separation, Stabilization, Incineration, Dewatering, Wastewater treatment facilities.

Large industries producing substantial quantities of similar wastes will find liability incentives for treating and, as much as possible, destroying hazardous wastes on-site. However, lower volume waste streams from large facilities and hazardous wastes from medium to small industrial facilities are usually not economic to treat with appropriate technology. In the past, much of this type of waste has been disposed of to municipal landfills. Because such disposal does nothing to reduce the quantity or noxious properties of the hazardous wastes nor can it provide assurance of containment, disposal regulations generally seek to eliminate this practice for the designated hazardous wastes. This situation requires the provision of centralized off-site facilities offering a range of common technologies which can handle the variable, smaller volume hazardous waste streams which industry finds uneconomic to treat on-site. Technologies such as neutralization, oxidation, reduction, chemical precipitation, oil/water separation, incineration, dewatering, and stabilization, which might be applicable to such centralized facilities are reviewed by describing the essential processes involved and the nature and quantity of residues produced by each. The disposal of the treatment residues is considered along with description of the approaches being implemented at the Swan Hills facility being constructed for the Alberta Special Waste Management Corporation. (See also W89-02155) (Lantz-PTT)
W89-02166

MODEL-BASED EDUCATION SUPPORT SYSTEMS: APPLICATION TO LARGE LAKES AND HAZARDOUS WASTE MANAGEMENT,
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
For primary bibliographic entry see Field 6A.
W89-02181

CLEANING ABANDONED CHEMICAL WASTE SITES AND THE LARGER PROBLEM OF PREVENTING NEW DUMPS,
Pollution Probe Foundation, Toronto (Ontario).
R. H. Hall.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 105-109.

Descriptors: *Chemical wastes, *Disposal sites, *Water pollution prevention, *Cleanup operations, Management planning, Information exchange, Databases, Chemical industry.

Niagara Falls, NY. contains some 215 chemical waste dumps within walking distance of the Falls. These dumps hold collectively about eight million tons of toxic chemicals whose environmental persistence is measured in hundreds of years. Waste dumping has been a by-product of the chemical industry since its inception, but most of that eight million tons has been dumped in the last 35-40 years: one reason, chemical production has expanded about 50-fold in that period. Two proposals for a systematic approach to the management of chemicals are offered: (1) Determine the goals which are to be achieved; and (2) Determine the information needed to formulate action policies to achieve these goals and what are the barriers to obtaining this information. The Goal: Zero discharge of chemicals into the Great Lakes, attained not by shutting down chemical industry, but by managing aggressively chemical manufacture, chemical use and chemical disposal within the continuing economic and social evolution of society. The Information: Systematic management of chemicals as proposed, requires new types of information. Much technical research data now generated and much current policy-making support only micro-management. An information base for systematic management to integrate also needs technical issues with social and economic planning. (See also W89-02176) (Lantz-PTT)
W89-02182

SIMULATIONS OF WATER AND SOLUTE MOVEMENT IN THE BURIED WASTE REPOSITORY AT VAALPUTS,
Natal Univ., Pietermaritzburg (South Africa). Dept. of Soil Science and Agrometeorology.
For primary bibliographic entry see Field 5B.
W89-02264

5F. Water Treatment and Quality Alteration

ALGAE FLOCCULATION IN RESERVOIR WATER,
Southern Petrochemical Industries Corp. Ltd., Tuticorin (India).
For primary bibliographic entry see Field 5G.
W89-01285

REACTION OF ORGANIC PHOSPHATE ESTERS WITH CHLORINE IN AQUEOUS SOLUTION,
Kitakyushu Municipal Inst. of Environmental Health Sciences (Japan).
For primary bibliographic entry see Field 5B.
W89-01303

REHAB FOR FILTRATION,
Black and Veatch, Denver, CO.
C. P. Houck, and M. B. Smith.
Civil Engineering CEWRA9, Vol, 58, No. 9, p 65-67, August 1988.

Descriptors: *Giardia, *Municipal water, *Water treatment facilities, *Filtration, Parasites, Giardiasis, Fort Collins, Colorado, Human diseases.

Fort Collins, Colorado relies completely on surface waters - snowmelt and rainwater. In evaluating the existing municipal water treatment system, it was decided to close one of the existing water treatment plants and to upgrade the other. The expansion project is described. One of the major considerations was to meet the EPA mandates for filtration removal of Giardia lamblia, the parasite responsible for waterborne giardiasis. (Sand-PTT)
W89-01348

CONTROLLING NITRATE LEACHING IN WATER SUPPLY CATCHMENTS,
For primary bibliographic entry see Field 5G.
W89-01349

LONDON WATER RING MAIN: AN OPTIMAL WATER SUPPLY SYSTEM,
M. A. Keane, and J. C. Kerslake.
Journal of the Institution of Water and Environmental Management, Vol. 2, No. 3, p 253-267, June 1988. 10 fig, 5 ref.

Descriptors: *London, *England, *Water supply, *Water conveyance, *Water mains, *Pipelines, Tunnels, Water treatment facilities, Engineering, Optimization, Simulation, Planning, Computer models.

An integrated strategy is described by which Thames Water plans to meet the growing water demand of London. At the core of the strategy is the construction of more than 60 km of deep tunnel (the London Water Ring Main) to convey water to major demand centers. The ring main will radically alter the way in which water is supplied to London, and a considerable amount of analytical work has been necessary to develop proposals and an operating system. Topics discussed include the history and description of the present system, the rationalization of London's treatment works, the proposed mode of operation of the ring main, computer modeling of the proposed ring main configuration and of the existing trunk supply system, engineering considerations, and implementation, including the three-tier control framework for managing the system. (Author's abstract)
W89-01350

GUINEA WORM AND WATER SUPPLY IN KORDOFAN, SUDAN,
London School of Hygiene and Tropical Medicine (England).
S. Cairncross, and A. Tayeh.
Journal of the Institution of Water and Environmental Management, Vol. 2, No. 3, p 268-274, June 1988. 4 fig, 3 tab, 12 ref.

Descriptors: *Sudan, *Nematodes, *Public health, *Water supply, *Epidemiology, *Drinking water, *Parasites, Infection, Reservoirs, Contamination, Wells, Pumps, Boreholes, Copepods, Crustaceans, Diseases, Human diseases.

A study of a guinea worm epidemiology in South Kordofan, Sudan found two different patterns of infection. In four villages, all with large open reservoirs (hafirs), the one-year period prevalence was more than 34%, and was not strongly related to age. In the remaining 23 villages, the prevalence did not exceed 20%, but was greater in adults than in children. The former pattern suggested contamination of the water carried home, while the latter appeared to be associated with casual use of water sources outside the village. Guinea worm disease was associated with the use of certain water sources, particularly in the poorly-maintained hafirs, but not with hand pumps, when these functioned, or open dug wells. In this context, open dug wells seem to be a more cost-effective intervention for guinea worm control than boreholes with hand pumps or the rehabilitation of hafirs. (Author's abstract)
W89-01351

RADIOACTIVITY IN WATER SUPPLIES,
R. G. Castle.
Journal of the Institution of Water and Environmental Management, Vol. 2, No. 3, p 275-284, June 1988. 3 fig, 3 tab, 16 ref.

Descriptors: *Radioactivity, *Drinking water, *Radon, *Groundwater pollution, *Water pollution, *Water quality standards, Water supply, Potable water, Groundwater, Monitoring, Water quality management, Chernobyl, Sludge, Water pollution sources, Powerplants, Nuclear powerplants, Radiation, Background radiation, Electric power production.

The general monitoring of radioactivity in the water industry is reviewed, and radioactivity

standards for potable water are described. Topics discussed include: monitoring equipment; including gamma-ray spectrometers; alpha spectrometers; and liquid scintillation counters; international approaches to defining radionuclide standards; the effect of the Chernobyl accident on rivers and water supplies; and natural radioactivity, specifically from uranium, radon-222, and radium. It is concluded that the main concern is to ensure that the water industry has the capacity to carry out adequate monitoring following the accidental release of radioactivity. Greater interest can subsequently be taken in the levels of natural radionuclides in groundwaters. (Doria-PTT)
W89-01352

PRACTICAL EXPERIENCE OF BOREHOLE PERFORMANCE EVALUATION,
A. C. Skinner.
Journal of the Institution of Water and Environmental Management, Vol. 2, No. 3, p 332-340, June 1988. 6 fig, 1 tab, 8 ref.

Descriptors: *Performance evaluation, *Boreholes, *Data acquisition, *Logging (Recording), *Pumping tests, Water yield, Drawdown, Pumping plants, Economic aspects, Monitoring, Water level, Flow, Aquifers, Pumps.

Severn-Trent Water (England) is engaged on a program of operational reviews within the water supply function. Standardized borehole performance tests form an essential part of the data gathering exercise. For some, particularly the older and smaller borehole sources, these tests are providing the first ever reliable documentation on their operational characteristics. The tests, linked where appropriate with geophysical and closed-circuit television (CCTV) logging, are indicating where borehole operation could be improved and where rehabilitative measures are desirable. The tests also provide the basis of the cost-output relationships necessary for modelling of the water supply system. The paper describes the program in more detail and illustrates by examples some of the beneficial results being achieved. (Author's abstract)
W89-01356

ESTIMATING COSTS MODEL OF DUAL WATER SUPPLY SYSTEMS,
Marsan (Andre) et Associes, Inc., Montreal (Quebec).
R. Leconte, T. C. Hughes, and R. Narayanan.
Journal of Water Resources Planning and Management (ASCE) JWPED5, Vol. 114, No. 5, p 547-564, September 1988. 3 fig, 7 tab, 24 ref, 2 append.

Descriptors: *Estimated costs, *Water conveyance, *Dual water supply systems, *Economic evaluation, *Impaired water use, Water supply development, Optimization, Estimating equations, Irrigation, Regression analysis, Performance evaluation, Spatial variation, Temporal variation, Cost analysis.

A mixed integer programming model is used to generate the optimal design of dual water supply systems. The water-supply network is of branched or nonlooped type, and the model selects discrete pipe sizes as well as optimal capacity and location of pumping stations. A distinct feature in the formulation of the modes is that it takes into account the spatial and temporal variability of the water demand through a nonlinear relationship between the design flow and the area to irrigate. The model is applied to a hypothetical example and its superiority to a nonlinear model is demonstrated. A real-world application is demonstrated and the model is then used in a regression analysis to simulate the cost of dual water systems. Applications of the regression equations to three real-world problems confirm the reliability of the method, with errors between observed and generated costs not exceeding eight percent. Limitations of the regression model are also discussed. (Author's abstract)
W89-01369

HEALTH ASPECTS OF THE USE OF RECYCLED WATER IN WINDHOEK, SWA/NAMIBIA, 1974-1983,
University of the Witwatersrand, Johannesburg (South Africa).
M. Isaacson, and A. R. Sayed.
South African Medical Journal, Vol. 73, No. 10, p 596-599, May 21, 1988. 3 fig, 2 tab, 11 ref.

Descriptors: *Water reuse, *Drinking water, *Public health, *Potable water, *Epidemiology, *Human disease, Social aspects, Economic status, Diarrhea, South West Africa, Namibia, Water quality, Microorganisms.

The introduction of the use of reclaimed water in Windhoek, SWA/Namibia, prompted an epidemiological study to assess the health effects, if any, of its consumption. Analysis of more than 15,000 episodes of diarrheal disease during the period August 1976 - March 1983 showed that their incidence in whites of similar socio-economic status was marginally lower in persons supplied with reclaimed water than those with water from conventional sources. Incidence rates were significantly higher in blacks and in coloreds, all of whom received conventional water only. Age-specific incidence rates in children of the various ethnic groups also showed differences characteristically associated with socio-economic stratification. It is concluded that the consumption of reclaimed water does not increase the risk of diarrheal diseases caused by waterborne infectious agents. (Author's abstract)
W89-01378

APPLICATIONS OF VYREDOX METHOD REGARDING IRON REMOVAL FROM GROUND WATER IN CHINA,
China Aeronautical Project and Design Inst., Beijing.
F. Maogong.
Ground Water GRWAAR, Vol. 26, No. 5, p 647-648, September-October 1988.

Descriptors: *Iron, *Heavy metals, *Water treatment, *Oxidation, China, Biological oxidation, Bacteria, Aquifers, Aeration, Groundwater, Recharge, Flow discharge.

The method is a chemical and biological contact oxidation process. After recharge of oxygen-rich water forced into the aquifer, the ferric hydroxide film which has been deposited on the surface of sand of the aquifer absorbs oxygen and iron from the water, and the catalytic reaction between oxygen and iron takes place on the surface of the sand grain, assisted by iron bacteria. Three ways of recharging are described. The ratio between discharge and recharge (efficiency ratio) was 4-13. The rate of recharge was 80% to 100% of the rate of discharge (pumping). The time of recharge was 3-51 hours. Details are presented for five Vyredox waterworks in China. (Author's abstract)
W89-01411

INTERNATIONAL COMPARISON OF WATER PRICES,
International Water Supply Association, London (England).
For primary bibliographic entry see Field 6C.
W89-01427

BRIEF INTRODUCTION TO TECHNICAL REFORMATION OF PURIFICATION FACILITIES IN SHANGHAI MUNICIPAL WATERWORKS COMPANY,
Shanghai Municipal Waterworks Co. (China).
S. Ren-Yuan.
Aqua AQUAAA No.4, p 178-182, 1988. 2 fig, 5 tab.

Descriptors: *Wastewater treatment, *Water treatment facilities, Municipal wastewater, Flocculation, Coagulation, Settling tanks, Economic aspects.

The dominant ideas and main steps of expansion and rehabilitation of Shanghai's muncipal water facilities are outlined. The principle objective was to improve or to maintain water quality. The baffled-plate flocculator was the most commonly used flocculation equipment in horizontal settling tanks. It had a lower construction cost, was convenient to maintain, and gave a better flocculation effect. The settling effect of a long rectangular tank (50-100 m) was better than a short one with the same settling time; the settling effect of straight flows was better than of those with bends. The settling effect of the water in the settling tanks without sludge sediment was better than in those with sludge sediment. The Shanghai waterwork used the declining rate method to filter water. The coagulation characteristics of the effluent were particularly important. When the water is coagulated under poor conditions, even though filtered at a low rate, the effluent quality is decreased. The Shanghai method saved on capital costs, and water quality and filter runs were improved. (Hammond-PTT)
W89-01428

INTERNATIONAL RIVERS RHINE AND MEUSE: RECENT DEVELOPMENTS IN THE FIELD OF THE PROTECTION AGAINST POLLUTION AND OF DRINKING WATER PRODUCTION IN THE NETHERLANDS INCLUDING THE PROBLEMS OF STORAGE AND EUTROPHICATION,
Water Storage Corp., Rotterdam (Netherlands).
E. G. H. Vreedenburgh.
Aqua AQUAAA No.4, p 183-192, 1988. 12 fig, 5 tab, 9 ref.

Descriptors: *International waters, *Water treatment, *Water pollution sources, *Netherlands, *Water pollution control, *Drinking water, Storage, Pollutants, Rivers, Surface water, Oil pollution, Contamination, Hazardous materials, Legal aspects, Rhine, Meuse.

The rivers Rhine and Meuse are the main sources for drinking-water production from surface water in the Netherlands. Some general facts about the Netherlands relations to these rivers and their pollution are outlined and the public water supply is described. The substances which have caused the greatest concern are those that are not greatly affected by the traditional water treatment plants, such as oils and solutes. Accidental spills of oil or chemical substances are the majority of pollution incidents. The threats of new developments include nuclear power plants, new contaminants, and increased abstraction of water. The national, international and legal aspects of surface water protection increase the difficulties in providing a safe water supply, as the Netherlands is a major consumer of the river water but contributes only a minor portion of the pollution. The major polluters are not under the Netherlands jurisdiction. (Hammond-PTT)
W89-01429

ACCIDENTAL WATER POLLUTION AND DRINKING WATER PRODUCTION: THE DAILY CHALLENGE ACCEPTED BY THE SYNDICAT DES EAUX D'ILE DE FRANCE AND THE COMPAGNIE GENERALE DES EAUX (POLLUTIONS ACCIDENTELLES DES EAUX ET PRODUCTION D'EAU POTABLE: LE DEFI QUOTIDIEN RELEVE PAR LE SYNDICAT DES EAUX D'ILE-DE-FRANCE ET LA COMPAGNIE GENERALE DES EAUX),
Anjou Recherche, Maisons-Laffitte (France).
P. Mousty, M. Dutang, and A. Grimaud.
Aqua AQUAAA No.4, p 193-198, 1988. 10 fig, 31 ref. English summary.

Descriptors: *Path of pollutants, *Warning systems, *Water treatment, *Spills, *Industrial wastes, *France, Storage tanks, Potable water.

The Compagnie Generale des Eaux supplies 4 million customers of the Syndicat des Eaux d'Ile de France almost exclusively from river water which is subject to accidental pollution. To guarantee safe supplies, the policy pursued involves an accurate knowledge of risks, pollution simulation studies and the installation of automatic warning stations. In the event of pollution, its scale is assessed by an analysis campaign. Counter-pollution measures are then taken with emergency reagents, stand-by equipment such as raw water storage tanks and

intercommunication between the various works. (Author's abstract)
W89-01430

IMPROVEMENTS IN WATERSHED MANAGEMENT YIELD ENHANCED REVENUES,
Washington Suburban Sanitary Commission, Brookeville, MD.
For primary bibliographic entry see Field 4A.
W89-01431

FUTURE RESEARCH FOR THE PRODUCTION OF DRINKING WATER,
Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).
H. Bernhardt.
Aqua AQUAAA No.4, p 205-208, 1988. 1 tab, 15 ref.

Descriptors: *Drinking water, *Water treatment, *Water quality control, *Research priorities, Planning, Monitoring.

Increasing demands on drinking-water quality and a continual rise in the loading of waters with micropollutants as well as the recently gained knowledge of undesirable effects of traditional water treatment processes on the purity of water require the development of new treatment techniques or modification of existing processes. As a consequence, new concentration limits are being developed for an increasing number of substances and classes of substances and the limits already determined for known compounds are being revised. Precautionary measures taken to ensure the health of the customer and which are part of national and international health policies are becoming increasingly important. Equally important is the development of monitoring methods and controlling processes which can be automated and operated by semi-skilled personnel. (Hammond-PTT)
W89-01432

DESIGN CRITERIA FOR THE REMOVAL OF ORGANIC MATTER FROM WATER WITH ALUMINUM,
McMaster Univ., Hamilton (Ontario). Dept. of Chemical Engineering.
E. Diamadopoulos, and D. R. Woods.
Aqua AQUAAA No.4, p 212-214, 1988. 3 fig, 22 ref.

Descriptors: *Aluminum, *Organic matter, *Water treatment, *Design criteria, *Coagulation, Filtration, Hydrogen ion concentration.

Based on data from the literature, a linear relationship was found between the initial total organic carbon of various waters and the optimum aluminum dosage, for removal of humic substances despite differences in the systems or the water sources. The slope of the straight line depended on the pH, with a lower pH resulting in a steeper slope. This important property can be used for design purposes to select the optimum aluminum dosage. Under conditions of low initial total organic carbon and low aluminum dosages, small changes in the total organic carbon or the aluminum dosage result in sharp changes in the removal after filtration. (Author's abstract)
W89-01434

CROSSFLOW MICROFILTRATION-FOULING MECHANISMS STUDIES,
Allied-Signal, Inc., Des Plaines, IL. Engineered Materials Research Center.
W. B. Bedwell, S. F. Yates, and, I. M. Brubaker., and S. Uban.
Separation Science and Technology SSTEDS, Vol. 23, No. 6 and 7, p 531-548, 1988. 10 fig, 3 tab, 10 ref.

Descriptors: *Fouling, *Filtration, *Membrane filters, *Water treatment, Fulvic acids, Humic acids, Chemical treatment, Flow, Membrane filter, Calcium carbonate, Surface water, Municipal water treatment.

Several mechanisms were found by which deterioration can occur in a process to treat a hard surface water feed using lime softening followed by crossflow microfiltration. Some mechanisms operate during the filtration and reflect characteristics of the dynamic membrane of solids. Other mechanisms operate during cleaning of the tubes and reflect either irreversible fouling of the nylon tubes by an impermeable skin of organic material or degradation of the porous tubes. An ideal filter cake contains a monodisperse system of particles, which tend to flocculate and form a loose, very porous solids matrix. Humic acids in surface water are small colloids (<1 micron). The calcium carbonate solids formed during water softening can be much larger (5-30 microns). At optimal lime softening pH (approximately 10.2), this system consists of large microns particles and small organic particles, which do not flocculate due to their common surface change. There are several strategies for improving performance. Increasing pH precipitates humic material and promotes flocculation. Adding an agent like ferric sulfate also promotes flocculation. Oxidation with ozone degrades humic acid and influences its characteristics charge in such a way as to promote flocculation. Whatever the treatment, a good dynamic membrane develops when the colloidal organic material is incorporated into or onto larger particles and the bimodal character of the size distribution is destroyed. Successful membrane cleaning relies on preventing precipitation of humic acid solids while the solids on which they are sorbed are dissolved. Either oxidation or addition of a surfactant can accomplish this. However, choice of the appropriate cleaning strategy must include consideration of the stability of the filter to the cleaning agent. In general, membranes are prone to fouling. these studies have shown that fouling occurs by a variety of mechanisms. Therefore, careful analysis of the interactions between all feed components and the membrane surface is an essential step prior to the implementation of a membrane process. (Hammond-PTT)
W89-01437

MAXIMUM LIKELIHOOD ANALYSIS OF DISINFECTION KINETICS,
Illinois Inst. of Tech., Chicago. Pritzker Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W89-01444

COMBINED ION EXCHANGE/BIOLOGICAL DENITRIFICATION FOR NITRATE REMOVAL FROM GROUND WATER UNDER DIFFERENT PROCESS CONDITIONS,
Agricultural Univ., Wageningen (Netherlands). Dept. of Water Pollution Control.
J. P. van der Hoek, P. J. M. van der Ven, and A. Klapwijk.
Water Research WATRAG, Vol. 22, No. 6, p 679-684, June 1988. 9 fig, 1 tab, 19 ref.

Descriptors: *Nitrate removal, *Groundwater pollution, *Denitrification, *Ion exchange, *Water treatment, Sulfates, Combined process, Brines, Biological regeneration, Nitrate selective resins, Chlorides, Regeneration, Ion exchange resins, Drinking water.

Combined ion exchange/biological denitrification is a process for nitrate removal from groundwater in which nitrate is removed by an ion exchanger and the resins are regenerated in a closed circuit through a biological denitrification reactor. The process was run at laboratory scale under three process conditions. Groundwater with a relatively low sulfate concentration (31 mg SO4(2-)/l) was treated with the sulfate-selective resin Duolite A 165 and with the nitrate-selective resin Amberlite IRA 999, with NaCl as a regenerant in both cases. Although the nitrate concentration in the treated water was hardly influenced by the different resin types, chloride and sulfate concentrations clearly were affected. With the nitrate-selective resin, sulfate concentrations were higher and chloride concentrations lower compared to the sulfate-selective resin. Treatment of groundwater containing a very high sulfate concentration (181 mg SO4(2-)/l) was possible by the combined process with the nitrate-selective resin. In all three cases sulfate accumulated in the regeneration circuit without impairing the nitrate removal in the service mode. The regenerant was renewed every 2 wk under on process condition. Compared with conventional ion exchange regeneration, this results in a 95% reduction of brine production. (Author's abstract)
W89-01445

EVALUATION OF DIRECT MICROSCOPICAL COUNTS AND ENDOTOXIN MEASUREMENTS AS ALTERNATIVES FOR TOTAL PLATE COUNTS,
Kongelige Veterinaer- og Landbohoejskole, Copenhagen (Denmark). Inst. of Veterinary Microbiology and Hygiene.
For primary bibliographic entry see Field 5A.
W89-01458

ILLNESS AND RESERVOIRS ASSOCIATED WITH GIARDIA LAMBLIA INFECTION IN RURAL EGYPT: THE CASE AGAINST TREATMENT IN DEVELOPING WORLD ENVIRONMENTS OF HIGH ENDEMICITY,
Texas Univ. Medical School at Houston. Program in Infectious Diseases and Clinical Microbiology.
For primary bibliographic entry see Field 5C.
W89-01525

WATER CLARIFICATION PROCESSES: PRACTICAL DESIGN AND EVALUATION,
Water and Air Research, Inc., Gainesville, FL.
H. E. Hudson.
Van Nostrand Reinhold Company, New York. 1988. 353p.

Descriptors: *Water treatment, *Clarification, *Water treatment facilities, Engineering, Hydraulic engineering, Flocculation, Mixing, Sedimentation, Jar tests, Flow patterns, Filtering, Washing.

This book is designed to serve as a reference book for those responsible for plant operation, for designers and consultants, and as a text for short courses for practicing engineers and for graduate course in treatment plant design. Important related topics that are examined include: jar testing and using jar test data; how to determine velocity gradients and residence time characteristics (mixed flow, plug flow, and dead space) in basins; basic concepts of mixing, flocculation; density considerations in sedimentation; horizontal flow and upflow sedimentation; behavior of filters; and, filter washing. In particular, it provides procedures and data for comparison of operating results from existing plants, for use in evaluating other existing plants. It also describes methods for the derivation of design criteria for new plants as well as modifications of existing plants. The engineering and hydraulic aspects of water clarification processes are emphasized. Theoretical aspects are treated only to the extent that they have been useful in practical design. (Lantz-PTT)
W89-01598

NALCO WATER HANDBOOK.
McGraw-Hill Book Company, New York. 1988. 1019p. 2nd ed. Edited by Frank N. Kemmer.

Descriptors: *Handbooks, *Water properties, *Water treatment, *Water use, Industrial water, Municipal water, Biological properties, Chemical properties.

This handbook provides orientation in water technology for those who need this information in an understandable form for their jobs, but may not necessarily aspire to becoming specialists in water treatment. The four parts of this handbook perform the following functions: part 1 introduces the nature of water and explores the fundamentals of chemistry, biology, water resources, and water analysis; part 2 presents, in detail, the unit operations of water conditioning; part 3 gives an overview of important industrial and municipal uses of water, including recycling and disposal; the typical operations of major industries, institutions, and municipalities are described to exemplify prevailing

industrial practices; and part 4 presents over specialized water treatment technologies, such as treatment for cooling purposes, steam generation, and oil recovery. (Lantz-PTT)
W89-01824

WATER TREATMENT AND REUSE,
Teesside Polytechnic, Middlesbrough (England). Dept. of Chemical Engineering.
T. Stephenson.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume II: Treatment and Disposal. CRC Press, Inc., Boca Raton, Florida, 1987. p 69-90, 1 fig, 7 tab, 107 ref.

Descriptors: *Wastewater treatment, *Water treatment, *Water reuse, *Heavy metals, Filtration, Coagulation, Flocculation, Activated carbon, Ion exchange, Reverse osmosis, Potable water.

Detrimental effects on potable water supplies due to the presence of heavy metals are possible due to the traditional role of surface waters in receiving industrial and domestic wastewater discharges. Surface waters that have been affected by man's activities are increasingly being used for drinking water supply as groundwater sources become exhausted and new sources are difficult to find, resulting in an increasing trend towards water reuse, both direct and indirect. Direct water reuse studies have indicated that the strategy for producing water is possible at a cost. Heavy metal contamination of the final water distributed in supply is one of several potential hazards to human health that has been considered. However, concentrations in the effluents reused have either been insignificantly, or nearly complete removal has been achieved during treatment. Metal removal has occurred during stages of treatment that have been included for another primary objective; e.g., activated carbon adsorption is effective in removing several heavy metals, but its main purpose is to remove organics, tastes, and odors. Bank filtration, coagulation and flocculation, sand filtration, activated carbon, ion exchange, and reverse osmosis, are presented as unit processes for the treatment of water for heavy metal removal. (See also W89-02104) (Lantz-PTT)
W89-02108

DRINKING WATER STANDARDS: THEIR DERIVATION AND MEANING,
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5G.
W89-02210

TREATMENT OF WATER FROM CONTAMINATED WELLS,
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
W. A. Feige, R. M. Clark, B. W. Lykins, and C. A. Fronk.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 235-251, 4 tab, 25 ref.

Descriptors: *Water treatment, *Groundwater quality, Groundwater pollution, Adsorption, Activated carbon, Aeration, Ion exchange, Reverse osmosis, Ozonation, Oxidation, Ultraviolet radiation, Volatile organics, Pesticides, Organic compounds.

The Drinking Water Research Division (DWRD) of EPA is responsible for evaluating the various types of technologies that might be used to meet the MCLs promulgated under the Safe Drinking Water Act and its Amendments. Because the source water for many utilities in the United States is groundwater, DWRD is especially concerned about conducting bench-, pilot- and field-scale studies on technologies that effectively treat groundwater. Technologies being examined are carbon adsorption, aeration, ion exchange, reverse osmosis, ozone oxidation, and ultraviolet light, some at the field scale and others at the bench and pilot scales. Carbon adsorption appears to provide removal for a wide range of organics whereas conventional treatment is revealed as a poor treatment for those compounds listed in the table. Packed tower aeration manifests itself as an excellent technology for volatile organic compounds and may have application for a limited number of pesticides. Ozone oxidation appears to be a good treatment technology for certain classes of organics such as simple alkenes and aromatics as well as certain similar, but more complex organic structures. Although only a few organics have been subjected to long-term testing via reverse osmosis, promising removals for several low molecular weight organics can be seen. (See also W89-02196) (Lantz-PTT)
W89-02212

CURRENT TRENDS IN WATER-SUPPLY PLANNING: ISSUES, CONCEPTS, AND RISKS,
D. W. Prasifka.
Van Nostrand Reinhold Co., New York. 1988. 266p.

Descriptors: *Water resources developement, *Water distribution, *Water supply, *Management planning, Urban areas, Water management, Water quality, Water rates, Economic aspects, Pricing, Risk analysis.

Strategies for supplying sufficient quantities of high quality water to urban areas, ensuring reliable supplies, and financing water-system capital needs comprise the core of this book. The text examines trends in water supply planning that have evolved in the past decade. These trends are embodied in myriad issues and concepts that emerged as a result of and in response to the dwindling of developable freshwater supplies in the nation. By incorporating these issues and concepts into the planning process, water managers can lower the level of risk associated with the development, protection, and use of water. The book explores the primary issue faced by water managers: the need for reliable forecasts of future water demands. It identifies both short- and long-term demand forecasting techniques, and it explains how to apply these techniques to specific projects. In addition, it evaluates the impacts of water conservation practices and water quality constraints on the forecasting process. Other important issues discussed in the book include: regionalization, the selection of a water supply planning philosophy, water rates and price structures, hazard mitigation and its impact on public policy, public participation in the planning process, and the determination of the social acceptability of a proposed water supply project or program. Emphasis is placed on identifying the practical applications of these issues and on gaining an understanding of the concepts that are used to describe them. (Lantz-PTT)
W89-02257

ANALYSIS OF WATER DISTRIBUTION SYSTEMS,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
T. M. Walski.
Van Nostrand Reinhold Co., New York. 1984. 275p.

Descriptors: *Water distribution, *Water conveyance, *Hydraulics, *Hydraulic structures, Pipes, Economic aspects, Computer models, Hydraulic models, Mathematical studies, Model studies, Data acquisition, Meters, Gages, Pumps.

Theoretical hydraulics and economics to practical applications of modeling, testing, and cost effective decision making are covered. A treatment of the basic equations of closed conduit hydraulics is especially useful, along with a discussion of computer models commonly used for solving hydraulic problems, which includes guidance on implementing and calibrating these models. Also discussed is the testing and metering of distribution systems, demonstrating how to collect data on flows, pipe roughness, diameters, pressures in the water distribution systems, and much more. Detailed coverage is included on: water distribution model skeletization and calibration; basic equations used in water system modeling; economic analysis of pipe breaks and replacement; collecting data for water system evaluation; selecting correct meters and gages; economics of pipe size selection; nomograms for hydraulic calculations and pipe size selection; and selecting pumps for water system applications. (Lantz-PTT)
W89-02259

5G. Water Quality Control

ALGAE FLOCCULATION IN RESERVOIR WATER,
Southern Petrochemical Industries Corp. Ltd., Tuticorin (India).
P. Sridhar, C. Namasivayam, and G. Prabhakaran.
Biotechnology and Bioengineering BIBIAU, Vol. 32, No. 3 , p 345-347, July 20, 1988. 2 fig, 1 tab, 8 ref.

Descriptors: *Reservoirs, *Algal control, *Flocculation, *Electroflocculation, *Alum, Aluminum electrodes, Comparison studies, Storage reservoirs, Cost analysis, Sulfates, Iron, Performance evaluation, Water treatment.

Algal populations in reservoir water can be effectively removed by either electroflocculation using aluminum electrodes or flocculation using alum. With electroflocculation there was a carry-over of aluminum(III) ion, whereas in the flocculation using alum there was no carry-over of aluminum(III), iron(III), or sulfate ions in the treated water. For the removal of algae, alum treatment is less expensive than electroflocculation. (Author's abstract)
W89-01285

HISTORY OF POINT SOURCE CONTROL OF NUTRIENTS IN PENNSYLVANIA AND OTHER CHESAPEAKE BAY STATES: PART I,
For primary bibliographic entry see Field 5D.
W89-01288

HISTORY OF POINT SOURCE CONTROL OF NUTRIENTS IN PENNSYLVANIA AND OTHER CHESAPEAKE BAY STATES: PART II,
W. A. Lyon.
Water Pollution Control Association of Pennsylvania Magazine Vol. 21, No. 5, p 7-14, September-October 1988. 3 fig, 1 tab, 27 ref.

Descriptors: *Chesapeake Bay, *Pennsylvania, *Eutrophication, *Estuaries, *Water pollution control, *Environmental policy, Water pollution sources, Enforcement, Great Lakes, Virginia, Maryland, Susquehanna River, Nutrients, Phytoplankton, Macrophytes, Oxygen depletion, Dam effects, Light depletion, Turbidity, Regulations, Legislation, Federal jurisdiction.

Studies of the impact of nutrients on the Chesapeake Bay, emergence of public policy to deal with the problem, implementation, municipal performance, and future prospects are discussed. The approach used to control pollution of the Chesapeake Bay is compared with that employed in the Lower Great Lakes Basin. Nutrient enrichment was considered a major factor affecting both phytoplankton and epiphyte growth in the Chesapeake Bay. Increased turbidity from sediment loads can be another light-limiting factor. A recent study of the Lower Susquehanna River Basin cited reduction in dissolved oxygen due to impoundments as an additional problem. Pennsylvania was one of the first states to establish point-source control of nutrients on a statewide basis. In the Lower Lakes and Susquehanna River Basins, Pennsylvania vigorously pursued point-source control of nutrients in the 1970s, generally before the other states (i. e., Maryland and Virginia with respect to the Chesapeake Bay). The efforts on the Lower Lakes were greatly expedited by a concise management plan tied to specific load targets. This approach was not applied on the Chesapeake Bay; consequently there is a lack of criteria for measuring progress. There also is less certainty about the relative importance of nutrients versus other pollutants. There is limited and less than convincing scientific evidence to support the relationship between nutrients and the decline of submerged aquatic vegetation and nutrients and deoxygenation. Nonpoint source pro-

grams need more management analysis to address priorities and to recognize the difference between man-made and natural events and sources. Here, too, Pennsylvania was the first to pass regulations designed to address the problem. The federal government's role was more important in shaping the program on the Lower Lakes than it has been on the Chesapeake Bay. (See also W89-01288) (Rochester-PTT)
W89-01289

'WHO'S ON FIRST' WITH RIGHT TO KNOW,
For primary bibliographic entry see Field 6E.
W89-01291

EUTROPHICATION OF THE COASTAL WATERS OF THE NORTH ADRIATIC SEA: NATIONAL AND REGIONAL INTERVENTION PROGRAMS,
Emilia-Romagna Regional Authorities, Bologna (Italy).
For primary bibliographic entry see Field 5C.
W89-01304

EUTROPHICATION OF INLAND AND COASTAL WATERS IN ITALY,
Istituto di Ricerca sulle Acque, Milan (Italy). Reparto Sperimentale di Idrobiologia Applicata.
For primary bibliographic entry see Field 5C.
W89-01305

SOLUBILITY RELATIONSHIPS OF ALUMINUM AND IRON MINERALS ASSOCIATED WITH ACID MINE DRAINAGE,
University of Wyoming Research Corp., Laramie. Western Research Inst.
P. J. Sullivan, J. L. Yelton, and K. J. Reddy.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 3, p 283-287, June 1988. 2 fig, 1 tab, 14 ref. Department of Energy Contract DE-AC2085LC11062.

Descriptors: *Waste disposal, *Path of pollutants, *Water pollution control, *Groundwater, *Acid mine drainage, *Pyrite, *Aluminum compounds, *Oil shale, Hydrogen ion concentration, Solubility, Sulfates, Sulfides, Water quality, Minerals, Iron compounds.

The ability to properly manage the oxidation of pyritic minerals and associated acid mine drainage is dependent upon understanding the chemistry of the disposal environment. One accepted disposal method is placing pyritic-containing materials in the groundwater environment. The objective of this study was to examine solubility relationships of Al and Fe minerals associated with pyritic waste disposed in a low leaching aerobic saturated environment. Two eastern oil shales were used in this oxidizing equilibration study, a New Albany Shale (unweathered, 4.6% pyrite), and a Chattanooga Shale (weathered, 1.5% pyrite). Oil shale samples were equilibrated with distilled-deionized water from 1-180 d with a 1:1 solid-to-solution ratio. The suspensions were filtered and the clear filtrates were analyzed for total cations and anions. Ion activities were calculated from total concentrations. Below pH 6.0, depending upon SO4 activity, Al solubility was controlled by AlOHSO4 (solid phase) for both shales. Initially, Al solubility for the New Albany Shale showed equilibrium with amorphous Al(OH)3. The pH decreased with time, and Al solubility approached equilibrium with AlOHSO4. Below pH 6.0, Fe solubility appeared to be regulated by a basic iron sulfate solid phase with the stoichiometric composition of FeOHSO4. The results indicate that below pH 6.0, Al and Fe solubilities are limited by basic Al and Fe sulfate solid phases (AlOHSO4 and FeHSO4). The results further indicate that the acidity in oil shale waters is produced from the hydrolysis of Al and Fe activities in solution. These results indicate a fundamental change in stoichiometric equations used to predict acidity from iron oxidation. Also, water quality predictions associated with acid mine drainage can be based on fundamental thermodynamic relationships. As a result, waste management decisions can be based on waste-specific/site-specific test methods. (See also W89-01323) (Author's abstract)
W89-01322

IMPACT OF MOSUL TEXTILE FACTORY EFFLUENTS ON TIGRIS RIVER WATER QUALITY,
Mosul Univ. (Iraq). Saddam Dam Research Centre.
For primary bibliographic entry see Field 5B.
W89-01326

EFFECTS OF COMMERCIAL LANDFILL BANS ON WASTE MINIMIZATION STRATEGIES AND TREATMENT PERFORMANCE STANDARDS,
RECRA Environmental, Inc., Amherst, NY.
For primary bibliographic entry see Field 5E.
W89-01341

WASTE REDUCTION: PROGRAM, PRACTICE AND PRODUCT IN CHEMICAL MANUFACTURING,
Dow Chemical Co., Midland, MI.
R. Delcambre.
Environmental Progress ENVPDI, Vol. 7, No. 3, p 175-179, August 1988. 7 fig, 2 ref.

Descriptors: *Waste recovery, *Chemical wastes, *Industrial wastes, *Chemical industry.

Waste reduction has been a daily pursuit of manufacturing operations for many years. During the 1970's, as feedstocks and energy costs escalated, a renewed emphasis was placed on yield improvement and energy conservation. These improvements, in many cases, reduced the volume of unwanted byproducts that had to be managed as waste and increased the overall productivity of the manufacturing process. (Author's abstract)
W89-01342

SOURCE REDUCTION TECHNICAL ASSISTANCE: A PILOT PROJECT AND ITS IMPLICATIONS FOR THE CHEMICAL INDUSTRY,
Massachusetts Dept. of Environmental Management, Boston.
L. Dane.
Environmental Progress ENVPDI, Vol. 7, No. 3, p 207-211, August 1988. 3 tab, 13 ref.

Descriptors: *Waste management, *Chemical wastes, *Industrial wastes, *Metal-finishing wastes, Chemistry industry, Hazardous materials.

As part of its developing source reduction program, the Massachusetts Department of Environmental Management (DEM) has conducted a technical assistance project with precious metals platers in the southeast region of the state. During this project, DEM identified a number of raw material substitutions and source reduction technologies that significantly reduce both costs and volumes of hazardous waste generated. DEM suggests ways in which the chemical industry might respond to market change, and details ways in which non-regulatory agencies can foster source reduction and encourage expanded markets for source reduction chemistries and technologies. (Author's abstract)
W89-01343

CONTROLLING NITRATE LEACHING IN WATER SUPPLY CATCHMENTS,
M. S. Knight, and S. B. Tuckwell.
Journal of the Institution of Water and Environmental Management, Vol. 2, No. 3, p 248-252, June 1988. 2 fig, 2 tab, 6 ref.

Descriptors: *Agricultural watersheds, *Nitrates, *Leaching, *Water pollution control, *Drinking water, Watersheds, Catchment areas, Fertilizers, Crop production, Cultivation, Agriculture, Springs, Grasslands, Cost analysis, Nonpoint sources.

Guidelines for reducing nitrate leaching from an agricultural catchment northeast of Bath, England are described. Springs from this catchment supply 80% of the water to a population of 96,000. By early 1987, 73% of Batheaston catchment and 43% of Monkswood catchment were subject to agreements between the Water Authority and the tenant or owner. These limit the use of nitrogen fertilizers and change arable land to permanent grass production or move arable crops away from the vulnerable areas of the catchment. These changes have reversed an upward trend in nitrate concentration in the springs, as reflected in the water supply. Nitrate content of the springs should continue to decline as the guidelines are extended to the remaining parts of the catchment. These measures have avoided the need for additional water treatment or alternative supplies. Control of agricultural activities was estimated to be the cheapest alternative for solving the nitrate problem in these supplies. (Author's abstract)
W89-01349

PROCEDURE FOR MANAGING CONTAMINATED DREDGED MATERIAL,
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
J. W. Male, and M. J. Cullinane.
Journal of Waterway, Port, Coastal, and Ocean Engineering (ASCE) JWPED5, Vol. 114, No. 5, p 545-564, September 1988. 4 fig, 3 tab, 7 ref, 2 append.

Descriptors: *Dredge spoiled disposal, *Spoil disposal, *Dredging, *Waste management, Sediments, Contamination, Planning, Waste disposal, Economic aspects, Legal aspects, Social aspects, Costs, Public opinion, Regulations, Environmental control.

Guidelines in the form of a flexible step-by-step procedure are presented for the management of contaminated dredged material. The guidelines are intended to assist decision-makers in their planning for dredging operations that could pose problems if not given special consideration. The procedure follows preliminary assessment of the contamination of sediment that is to be dredged. The procedure assists in the determination of appropriate and compatible means for dredging, transport, treatment, and disposal of dredged material. It combines means into viable alternatives which are then evaluated on the basis of several criteria: reliability, technical effectiveness, environmental impact, cost, regulatory requirements, public acceptance, safety, and practicality. (See also W89-01359) (Author's abstract)
W89-01358

MANAGING CONTAMINATED DREDGED MATERIAL: APPLICATION,
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
J. W. Male, M. J. Cullinane, and K. Phillips.
Journal of Waterway, Port, Coastal, and Ocean Engineering (ASCE) JWPED5, Vol. 114, No. 5, p 565-581, September 1988. 3 fig, 7 tab, 10 ref, append.

Descriptors: *Spoil disposal, *Dredge spoil disposal, *Waste management, *Dredging, Environmental control, Decision making, Case studies, Waste disposal, Cost analysis, Planning, Estuaries, Commencement Bay, Washington.

A procedure that was developed to assist decision-makers plan for proper management of contaminated dredged material is illustrated with the use of a case study. Decisions regarding dredging operations of contaminated dredged material are outlined for a project in Commencement Bay, Tacoma, WA. Preliminary screening of potential disposal sites is described and using criteria developed for the case study. In addition, appropriate means for dredging, transport, treatment, and disposal are determined and combined into alternatives. Viable alternatives are evaluated using criteria established as part of the overall decision-making procedure. Final selection of an alternative is presented in terms of two objectives: cost minimization and maximization of a composite qualitative criterion which incorporates several characteristics of each alternative. (See also W89-01358) (Author's abstract)

W89-01359

ASSESSING THE RISK OF VIOLATING STREAM WATER QUALITY STANDARDS,
Wyoming Univ., Laramie. Dept. of Civil Engineering.
W. E. Hathhorn, and Y.-K. Tung.
Journal of Environmental Management JEVMAW, Vol. 26, No. 4, p 321-338, June 1988. 15 fig, 1 tab, 20 ref, append.

Descriptors: *Water pollution control, *Risk, *Water quality standards, *Water quality management, *Impaired water quality, *Dissolved oxygen, Biochemical oxygen demand, Simulation analysis, Probability distribution, Stream pollution, Monte Carlo methods, Streeter-Phelps equation, Stochastic process.

For many years, managing agencies have enacted and enforced water quality standards based on a deterministic evaluation of the stream environments under their control. Given the random nature of the processes occurring within a stream system, the deterministic approach to water quality regulation is subject to obvious shortcomings. In an attempt to improve water quality regulation, a method is presented for quantifying the joint risk associated with dissolved oxygen deficits exceeding a specified standard and the length of such violations within a stream environment. Techniques are employed utilizing the Streeter-Phelps equation in conjunction with Monte Carlo simulation. In addition, flexibility is provided in the formulation by allowing several probability distributions and statistical properties assumed for each parameter. Implied in the methods and results presented is the development of improved water quality standards incorporating the inherent stochastic nature of stream environments. (Author's abstract)
W89-01373

DISEASE HAZARDS OF IRRIGATION SCHEMES,
Mahidol Univ., Bangkok (Thailand). Faculty of Tropical Medicine.
For primary bibliographic entry see Field 6G.
W89-01379

IMPROVEMENTS IN WATERSHED MANAGEMENT YIELD ENHANCED REVENUES,
Washington Suburban Sanitary Commission, Brookeville, MD.
For primary bibliographic entry see Field 4A.
W89-01431

TREATMENT OF LANDFILL LEACHATES IN ON-SITE AERATED LAGOON PLANTS: EXPERIENCE IN BRITAIN AND IRELAND,
Aspinwall and Co., Shrewsbury (England).
For primary bibliographic entry see Field 5D.
W89-01451

SYSTEMS ANALYSIS,
North Carolina Agricultural and Technical State Univ., Greensboro. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W89-01461

ECONOMICS,
East Texas State Univ., Commerce.
For primary bibliographic entry see Field 6B.
W89-01462

LAW (1987 AMENDMENTS),
Nixon, Hargraves, and Doyle, Rochester, NY.
For primary bibliographic entry see Field 6E.
W89-01463

ON-SITE ALTERNATIVES FOR TREATMENT AND DISPOSAL,
ERT, A Resource Engineering Co., Concord, MA.
For primary bibliographic entry see Field 5D.
W89-01475

HEALTH EFFECTS ASSOCIATED WITH WASTEWATER TREATMENT, DISPOSAL, AND REUSE,
Alberta Univ., Edmonton. Div. of Health Services Administration.
For primary bibliographic entry see Field 5D.
W89-01480

AGRICULTURAL WASTES,
Georgia Tech Research Inst., Atlanta.
For primary bibliographic entry see Field 5D.
W89-01486

TEXTILE WASTES,
ERT, A Resource Engineering Co., Concord, MA.
For primary bibliographic entry see Field 5D.
W89-01487

COAL AND COAL MINE DRAINAGE,
Tennessee Valley Authority, Chattanooga. Div. of Air and Water Resources.
H. Olem.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 886-890, June 1988. 67 ref.

Descriptors: *Literature review, *Mine drainage, *Coal mining, *Water pollution control, Regulations, Chemical properties, Model studies, Land reclamation, Coal cleaning, Transportation, Mining industry, Legislation, Industrial wastes.

Literature published in 1987 on coal industry wastes and coal mine drainage in relation to water pollution control is summarized under the following headings: environmental regulations, coal mine drainage characterization (regional, chemical, and biological), coal mine drainage process and mitigation studies, coal mine drainage models, coal cleaning, and coal transportation and storage. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01488

PETROLEUM PROCESSING AND SYNTHETIC FUELS,
Scholler, P.O. Box 26968, Philadelphia, PA 19134.
For primary bibliographic entry see Field 5D.
W89-01489

POWER INDUSTRY WASTES,
Tennessee Valley Authority, Knoxville. Environmental Quality Staff.
M. L. Iwanksi, and T. J. Chu.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 893-904, June 1988. 1 tab, 189 ref.

Descriptors: *Literature review, *Electric power industry, *Water pollution control, *Regulations, *Acid rain, Cooling water, Ash disposal, Waste disposal, Hydroelectric plants, Fossil fuels, Nuclear powerplants, Fluidized bed process, Industrial wastes, Water pollution sources, Hazardous wastes, Solid wastes, Radioactive wastes.

Literature published in 1987 on power industry wastes is summarized under the following headings: environmental regulation, hydroelectric power plants, fossil-fueled power plants (acid deposition, ash disposal and use, cooling system and cooling water discharge, and flue gas desulfurization), and nuclear power plants (waste characterization, treatment and disposal), and fluidized bed combustion. Environmental regulatory actions related to the power generating industry are summarized in a table covering water, solid and hazardous wastes, and radioactive wastes. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01490

CHEMICALS AND ALLIED PRODUCTS,
Union Carbide Corp., South Charleston, WV.
For primary bibliographic entry see Field 5D.
W89-01492

RADIOACTIVE WASTES,
New Mexico Univ., Albuquerque. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W89-01493

SOLID AND HAZARDOUS WASTES AND WATER QUALITY,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
M. E. Tittlebaum.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 920-924, June 1988. 54 ref.

Descriptors: *Literature review, *Solid wastes, *Hazardous wastes, *Water quality control, *Wastewater treatment, Legal aspects, Water pollution effects, Toxicity, Aquatic organisms, Drinking water, Model studies, Wastewater collection, Wastewater treatment, Design criteria, Sampling, Monitoring, Wastewater analysis.

Literature published in 1987 on solid and hazardous waste and water quality is summarized under the following headings: legal aspects; impact (toxicity to aquatic organisms, threats to drinking water); modeling and analysis; collection, treatment, and design techniques; and sampling and monitoring. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01494

NONPOINT SOURCES,
Northwest Colorado Council of Governments, Frisco.
L. Wyatt, J. Spooner, W. Berryhill, S. L. Brichford, and A. L. Lanier.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 925-933, June 1988. 161 ref.

Descriptors: *Literature review, *Water pollution sources, *Nonpoint pollution sources, *Path of pollutants, *Water pollution control, Policy making, Best management practices, Monitoring, Water analysis, Economic aspects, Management planning.

Literature published in 1987 on nonpoint sources (NPSs) of water pollution is summarized under the following headings: NPS policy, economics, and planning; water quality and water resources; best management practices and NPS control; and NPS monitoring, modeling, and analytical methods. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01495

LAKE AND RESERVOIR MANAGEMENT,
Environmental Protection Agency, Dallas, TX. Region VI.
D. B. McDonell, and P. A. Crocker.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 940-959, June 1988. 408 ref.

Descriptors: *Literature review, *Lakes, *Reservoir management, *Acid rain, *Lake management,

*Water pollution control, *Eutrophication, Nitrogen, Phosphorus, Nutrients, Sediments, Heavy metals, Herbicides, Viruses, Bacteria, Protozoa, Macrophytes, Algae, Phytoplankton, Limnocorrals, Periphyton, Algae, Zooplankton, Macroinvertebrates, Fish, Aquatic habitats, Fisheries, Reproduction, Food habits, Ecology.

Literature published in 1987 on lake and reservoir management in relation to water pollution control is summarized under the following headings: water quality (physicochemical studies, dissolved oxygen, ecosystem management and modelling, and in-lake treatment); nutrients (nitrogen, phosphorus, and nutrient management); sediment; toxic chemicals (heavy metals, herbicides and other organic chemicals, and contaminated sediments); acid deposition (atmospheric deposition, modeling, neutralizing capacity, and biological effects); viruses, bacteria, and protozoa; aquatic macrophytes; algae (phytoplankton, periphyton, and limnocorral experiments); zooplankton; macroinvertebrates; and fisheries (feeding strategies and food preference, reproduction, environmental factors and habitat). The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01497

DISSOLVED OXYGEN IN STREAMS AND RESERVOIRS,
Tennessee Valley Authority, Chattanooga.
W. L. Poppe.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 959-961, June 1988. 40 ref.

Descriptors: *Literature review, *Dissolved oxygen, *Rivers, *Reservoirs, *Water pollution control, Gases, Water pollution effects, Model studies, Lakes.

Literature published in 1987 on dissolved oxygen in streams and reservoirs in relation to water pollution control is summarized under the following headings: water quality in streams and reservoirs, water quality models, gas transfer, and aquatic effects and modeling. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01498

GROUNDWATER QUALITY,
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 5B.
W89-01499

FATE OF POLLUTANTS,
Environmental Protection Agency, Gulf Breeze, FL. Gulf Breeze Environmental Research Lab.
For primary bibliographic entry see Field 5B.
W89-01501

HUMAN HEALTH EFFECTS ASSAYS,
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 5A.
W89-01506

INTERNATIONAL ENVIRONMENTAL LAW AND POLICY: AN OVERVIEW OF TRANSBOUNDARY POLLUTION,
Illinois Univ. at Chicago Circle.
For primary bibliographic entry see Field 6E.
W89-01514

RECENT DEVELOPMENTS IN THE LAW OF THE SEA 1984-1985,
For primary bibliographic entry see Field 6E.
W89-01515

MARINE POLLUTION: INJURY WITHOUT A REMEDY,
Mississippi Univ. Law Center, University.
For primary bibliographic entry see Field 6E.
W89-01517

PROCEEDINGS OF THE NWWA/API CONFERENCE ON PETROLEUM HYDROCARBONS AND ORGANIC CHEMICALS IN GROUND WATER-PREVENTION, DETECTION AND RESTORATION.
For primary bibliographic entry see Field 5B.
W89-01530

KEY TO PREVENTING CONTAMINATION OF GROUNDWATER BY PETROLEUM PRODUCTS: FLORIDA'S SUPER ACT,
Florida State Dept. of Environmental Regulation, Tallahassee.
C. Ash, C. Garrett, and S. Gray.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 3-10, 10 ref.

Descriptors: *Water quality control, *Water pollution prevention, *Groundwater pollution, *Oil spills, *SUPER Act, *Florida, Pollutant identification, Cleanup operations, Water pollution treatment, Leakage, Storage tanks, Legal aspects, Liability.

Florida's governmental response to the problem of groundwater contamination from leaking petroleum storage systems emphasizes early detection of contamination rather than enforcement actions against the responsible party. Historically, enforcement actions have resulted in delayed cleanup or nonreporting of contamination sites. In an effort to protect public drinking water supplies, the Florida Legislature enacted the State Underground Petroleum Environmental Response Act of 1986 (SUPER Act). This bill created a trust fund from taxation on petroleum and other pollutants produced or imported into the state. This fund provides monies for the state to conduct site rehabilitation projects or for reimbursement to persons who have voluntarily or through negotiated enforcement cleaned up their site. Participation in the program is encouraged by the establishment of a grace period during which owners or operators of petroleum storage systems that report suspected contamination will not be held liable for the costs of restoring their sites. The Early Detection Incentive Program was started on July 1, 1986 and runs until September 30, 1988. As of September 1, over 2,300 applications have been submitted to the program. The order in which eligible sites receive reimbursement of costs or state contracted cleanup is determined by their environmental threat score, a priority ranking system which assesses the potential threat to public health or the environment. In this manner, those sites that pose the greatest potential for contaminating Florida's groundwater are quickly contained and cleaned up. Strong regulations governing Florida's underground petroleum storage tanks systems in combination with incentives for reporting suspected contamination will ensure a successful program in preventing serious groundwater contamination problems. (See also W89-01530) (Author's abstract)
W89-01531

COMPARISON OF GROUND WATER CLEANUP LEVELS; TWO CASE HISTORIES,
IT Corp., Monroeville, PA.
E. Medlin.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 13-18.

Descriptors: *Groundwater pollution, *Cleanup operations, *Water pollution treatment, *Benzenes, Leakage, Path of pollutants, Water pollution prevention, Water pollution control, Soil contamination, Hazardous wastes, Gasoline, Storage tanks, Case studies.

An important consideration when developing a plan to remediate contaminated soil or groundwater is the level of water quality desired. Two case histories are discussed which involve clean limits for groundwater contamination. Both situations were under the jurisdiction of the same environmental regulatory agency and involved the same contaminant; however, due to the nature of the release, inflexible, nonsite-specific cleanup standards were imposed at one site while flexible, site-specific levels were permitted for the other site. The final remediation costs for these two sites vary considerably and are a direct result of the clean levels. A benzene spill occurred at the first site. The regulatory agency applied existing local hazardous waste regulations to establish a clean level of total removal. In this case, an inflexible cleanup goal was based on policy and regulatory interpretation rather than site conditions. Since total removal of benzene from the groundwater was the imposed standard, the responsible party was legally locked into an open-ended, expensive remediation program. At the second site, a leak in an underground storage tank allowed several hundred gallons of gasoline to contaminate the soil and groundwater. At that time, because laws did not exist to guide remediation of a gasoline spill, the regulatory agency asked for a cleanup goal proposal concurrent with free gasoline recovery. The responsible party conducted a receptor analysis that showed that human health or environmental impact was not expected as a result of the benzene component of the gasoline. Action over and above product recovery was not required. The total remediation cost for the gasoline site was much lower than the estimated costs to remove all the benzene from groundwater at the first site. Comparison of these two case histories illustrates the merit of site-specific, realistic clean levels developed to protect human health and the environment. (See also W89-01530) (Author's abstract)
W89-01532

USE OF RISK ASSESSMENT TO DEFINE A CORRECTIVE ACTION PLAN FOR LEAKING UNDERGROUND STORAGE TANKS,
Gradient Corp., Cambridge, MA.
For primary bibliographic entry see Field 6E.
W89-01533

THREE LOW COST PUMPING SYSTEMS FOR HYDROCARBON CONTAMINATED GROUND WATER,
Geoscience Consultants Ltd., Albuquerque, NM.
C. A. J. Schleyer.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 43-54, 4 fig.

Descriptors: *Hydrocarbons, *Groundwater pollution, *Pumps, *Cleanup operations, *Oil recovery, Pumping, Separation techniques, Water pollution treatment, Water pollution prevention, Organic compounds.

Remedial action for hydrocarbon contaminated groundwater generally requires pumping to remove the floating product and associated contaminated water. These pumping systems are often unnecessarily elaborate and expensive. Three low cost pumping systems have been developed which are suitable for many hydrocarbon contaminated groundwater situations. These systems are constructed from readily available equipment and cost less than $1000 each, complete with necessary controls and protection devices. All three of these systems are in use at an oil refinery which has exhibited several zones of groundwater contamination by hydrocarbon products. Each of these zones presented a different set of conditions to which the three different pumping systems were matched. Operating the three systems at the same site has provided an opportunity for evaluation and comparison of the different pumps. Each of the pumps

will fit in a 6 inch well and is designed to extract water from the top of the water column in the well in order to remove all floating product which accumulates. The pumps also remove some water from the well to maintain a drawdown and induce the flow of floating product into the well. The three low cost pumping systems are: the pneumatic displacement pump, the modified jet pump, and the modified submersible pump. The pneumatic displacement pump is a custom manufactured, top filling, air operated pump suitable for low yield wells. The modified jet pump is installed in a sump into which the product flows, suitable for low to moderate yields. The modified submersible pump has a reverse shroud which is placed over the pump to force water to enter from the top, and cooling water is supplied to the motor. This pump is suitable for moderate to high flow rates. (See also W89-01530) (Author's abstract)
W89-01534

PRACTICAL APPROACH TO HYDROCARBON RECOVERY AT MARINE TERMINALS,
Engineering Enterprises, Inc., Long Beach, CA.
E. C. Henry, and D. Hayes.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 75-90, 8 fig, 2 ref.

Descriptors: *Hydrocarbons, *Oil recovery, *Groundwater pollution, *Cleanup operations, *Pumps, Marine environment, Test wells, Storage tanks, Oil spills, Pumping, Separation techniques, Leakage, Monitoring, Wells, California.

Bulk liquid terminals at port facilities typically possess unique characteristics relative to the presence, distribution and recovery of leaked hydrocarbons. However, these same characteristics allowed for a practical approach to the assessment and subsequent recovery of free hydrocarbon product from the shallow subsurface of a marine terminal. Despite access limitations due to site physical characteristics, the typical shallow groundwater conditions enabled the use of hand auger methods to drill borings and construct monitoring wells. The shallow depth-to-ground-water also allowed the use of pneumatically-driven suction lift pumps for recovery of free hydrocarbon product present on the water table. Through the use of multiple shallow recovery wells manifolded to the pumps, containment of serious hydrocarbon seepage to harbor waters has been accomplished. Since initiation of the first system in Los Angeles Harbor, four additional systems have been installed on the West Coast with similar success. (See also W89-01530) (Author's abstract)
W89-01536

OPTIMIZING RECOVERY OF CONTAMINANT RESIDUALS BY PULSED OPERATION OF HYDRAULICALLY DEPENDENT REMEDIATIONS,
Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
J. F. Keely, C. D. Palmer, R. L. Johnson, M. D. Piwoni, and C. D. Enfield.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 91-104, 6 fig.

Descriptors: *Groundwater pollution, *Cleanup operations, *Sorption, *Pumping, *Injection wells, Aquifers, Groundwater movement, Computer models, Organic compounds, Evaluation.

The Oregon Graduate Center, with co-funding from the U.S. Environmental Protection Agency and the U.S. Air Force, is currently undertaking a major study of the pulsed pumping remediation technique to examine its benefits, costs, and complications in delivery and recovery operations associated with conventional and in-situ remediation of groundwater contamination. Four objectives for the project exist: (1) to examine factors that influence the operational characteristics of hydrodynamically dependent in-situ remediations; (2) to determine the theoretical and practical potentials for improved delivery and recovery by pulsed pumping; (3) to characterize the efficiency of conventional hydrodynamically dependent remediations, relative to pulsed pumping simulations of remediations at select sites; and (4) to provide decision support information needed by the co-sponsors to determine the feasibility and desirability of a field demonstration project. The research approach involves a cost-effective combination of computer simulations, laboratory experiments, and preparations for a field demonstration. The major deliverable of the project is the Project Technical Report which will serve as a complete record of all computer simulations, laboratory experiments, and field surveys conducted during the project. The second major deliverable is a Design and Operation Manual for pulsed pumping operations. The third is a briefing document that summarizes the benefits, costs, and complications of pulsed pumping as determined by this project, and lays out the options for a field demonstration project. (See also W89-01530) (Geiger-PTT)
W89-01537

ELECTRO-OSMOTIC REMOVAL OF BENZENE FROM A WATER SATURATED CLAY,
Jordon (E.C.) Co., Wakefield, MA.
E. P. Van Doren, and C. J. Bruell.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 107-126, 8 fig, 5 tab, 11 ref.

Descriptors: *Benzenes, *Clays, *Electro-osmosis, *Water pollution treatment, *Model studies, Cleanup operations, Hydraulic gradient, Soil porosity, Hydrogen ion concentration, Separation techniques, Membrane processes, Water pollution prevention, Gasoline, Groundwater pollution, Osmosis.

The potential for electro-osmotic removal of benzene from water saturated clay with a low hydraulic conductivity was investigated. Experiments were designed to evaluate the removal process and to measure physical and chemical changes which occurred in the clay as a result of electro-osmotic treatment. Experimental results for contaminant removal were compared with values predicted using a one-dimensional transport model which incorporated advection, dispersion, and adsorption of the contaminant. Clay column reactors were constructed of 2.5 inch (diameter) glass tubing and contained steel electrodes, 6 inch clay column, and tap water electrolyte. The design of the columns allowed the measurement of benzene within the saturated clay and in the electro-osmotic effluent. A voltage gradient of 1 volt per inch of clay was impressed between electrodes and columns were electro-osmotically pumped until the benzene concentration was below detectable levels. The physical and chemical changes measured were pH and porosity within the clay column. Measurements were made following various treatment times. Experimental results indicated that electro-osmosis behaved as a hydraulic gradient and completely flushed benzene from the clay. This was accomplished in less than 2 pore volumes of the clay column after 2 weeks of treatment. Column pH dropped to 4.2 as a result of acidic anode solution moving into the clay column. Porosity of the clay column decreased in the vicinity of the cathode but remained unchanged at the anode. This porosity change occurred after less than 2 days of electro-osmotic treatment. (See also W89-01530) (Author's abstract)
W89-01538

NITRATE REMEDIATION OF GASOLINE CONTAMINATED GROUND WATERS: RESULTS OF A CONTROLLED FIELD EXPERIMENT,
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
K. Berry-Spark, and J. F. Barker.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 127-144, 7 fig, 2 tab, 23 ref.

Descriptors: *Gasoline, *Nitrates, *Biodegradation, *Water pollution treatment, *Benzenes, Injection wells, Plumes, Piezometers, Water pollution prevention, Path of pollutants, Sand aquifers.

A natural gradient field injection experiment was conducted to evaluate nitrate addition as a measure for in situ remediation of gasoline contaminated ground waters. Of particular concern were the very soluble, monoaromatic hydrocarbons: benzene, toluene, ethyl benzene, and xylene isomers (BTEX). A laboratory experiment indicated that BTEX from gasoline may be utilized during denitrification. Transformation of BTEX occurred only after a considerable lag period and transformation rates were much slower than reported aerobic biodegradation rates. Two plumes of gasoline contaminated groundwater were created by injection into the highly instrumented experimental unconfined sand aquifer at Canada Forces Base Borden. Immediately upgradient from one plume, groundwater spiked with nitrate was injected. The slightly retarded organic contaminants were completely overtaken by the unretarded nitrate within 148 days of the injection. The gasoline contaminated plume overtaken by nitrate represents the remediation scheme. The other gasoline contaminated plume received no treatment (unremediated) and was indicative of the natural attenuation of such contamination. Samples of the plumes were obtained from closely spaced multilevel piezometers 8, 30, 78, 113, and 148 days after the injection. From the resulting extensive three-dimensional solute distribution, estimates of the mass remaining in solution and center of mass were made for each monoaromatic. The effect of nitrate addition to gasoline contaminated water was determined through comparison of the behavior of the unremediated and remediated plumes. Comparison of the masses remaining in the unremediated and remediated plumes with time, indicated small but detectable differences in mass removal rates. Nitrate addition apparently hastened biotransformation. (See also W89-01530) (Author's abstract)
W89-01539

ENHANCED BIORECLAMATION, SOIL VENTING AND GROUND-WATER EXTRACTION: A COST-EFFECTIVENESS AND FEASIBILITY COMPARISON,
EA Engineering, Science, and Technology, Inc., Lafayette, CA.
R. E. Hinchee, D. C. Downey, and E. J. Coleman.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 147-164, 5 tab, 24 ref.

Descriptors: *Water pollution treatment, *Groundwater pollution, *Cleanup operations, *Pumping, *Hydrocarbons, Separation techniques, Cost analysis, Comparison studies, Water pollution prevention, Capital costs, Biodegradation.

In selecting a remedial alternative for cleanup of fuel hydrocarbon sites the objective is to choose the most cost-effective alternative that will achieve the desired objectives. The key features of the pump and treat method, the soil venting method and enhanced bioreclamation are compared. The pump and treat method is widely used to contain and slowly remediate contaminated groundwater. The soil venting method is a newly adapted technology that rapidly remediates vadose zone soil contamination, and gives limited treatment of shallow groundwater. Soil venting is only applicable to volatile compounds. Enhanced bioreclamation has been shown to be feasible only in limited field demonstrations. It is applicable to most fuel hydrocarbons at relatively permeable sites. In general, soil venting has the lowest cost per pound or gallon of fuel remediated. Based on an assumption of new saturated conditions, the following comparison of the number of pounds per day of hydrocarbon removed per horsepower is 8.9 for enhanced bioreclamation, 83 for soil venting, and 12 for groundwater extraction. Bioreclamation assumes a 1-horsepower pump lifting 10 gpm 20 feet with the

addition of 500 mg/l peroxide; soil venting, a 1-horsepower blower extracting 50 cfm of 5,000 ppm hydrocarbon vapor; and extraction. Groundwater extraction assumes 1-horsepower pump lifting 10 gpm of hydrocarbon-saturated (100 mg/l) groundwater 20 feet. Although enhanced bioreclamation appears to be the most expensive and least proven of these alternatives, it is the only currently available in-situ remedial technology that might clean up heavier nonvolatile hydrocarbons or deeper hydrocarbons in a reasonable time period, or that has the potential to result in total in-situ oxidation and destruction of contaminants. (See also W89-01530) (Geiger-PTT)
W89-01540

APPLICABILITY OF IN-SITU BIORECLAMATION AS A REMEDIAL ACTION ALTERNATIVE,
Biosystems, Inc., Chester, PA.
M. D. Lee, V. W. Jamison, and R. L. Raymond.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 167-185, 2 fig, 3 tab, 15 ref.

Descriptors: *Groundwater pollution, *Water pollution treatment, *Cleanup operations, *Organic compounds, *Biodegradation, Aquifers, Path of pollutants, Injection wells, Groundwater movement, Pumping, Toxicity, Site selection.

In-situ bioreclamation can be used to clean up groundwater systems contaminated with organic chemicals. The process works by stimulating the growth of the indigenous microbial population to degrade the contaminants in the aquifer. Oxygen and nutrients are added to the groundwater using injection wells and infiltration galleries. The groundwater is moved through the formation by pumping wells. Several factors must be considered before in-situ bioreclamation is chosen as the remedial alternative for the cleanup of a particular site. The factors can be divided into three categories: (1) site characteristics, (2) contaminant characteristics, and (3) microbial characteristics. Foremost in the site characteristics is the ability to move water through the formation at sufficient rates for a timely solution to be effected. The most important characteristics of the contaminants are their biodegradability and potential toxicity to the microorganisms. Many common groundwater contaminants are readily biodegradable. Others may be degradable at somewhat slower rates and less completely, while some compounds are probably not amenable to in-situ bioreclamation. The microbial characteristic of importance is the presence of an acclimated population. For many situations, but not all, in-situ bioreclamation will be an effective remedial action alternative. (See also W89-01530) (Author's abstract)
W89-01541

BIODEGRADATION OF CHLORINATED CHEMICALS IN GROUNDWATER BY METHANE OXIDIZING BACTERIA,
Cambridge Analytical Associates, Inc., Boston, MA. Bioremediation Systems Div.
S. Fogel, M. Findlay, A. Moore, and M. Leahy.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 187-206, 4 fig, 3 tab, 20 ref. EPA Small Business Innovative Research Grants 68-02-4113 and 68-02-4147. NSF Small Business Innovative Research Grant ISI-8560700.

Descriptors: *Biodegradation, *Chlorinated hydrocarbons, *Bacteria, *Groundwater pollution, *Water pollution treatment, Cleanup operations, Biotransformation, Oxidation, Methane, Plumes, Path of pollutants.

Experiments were undertaken to demonstrate the feasibility of biodegrading chlorinated compounds in groundwater over a range of environmental conditions. The biodegradation and mineralization of trichloroethylene by methane oxidizing bacteria was demonstrated. Chloroform, vinyl chloride, methylene chloride, isomers of dichloroethylene and ethylene dibromide were also biodegraded. Similar experiments were conducted in groundwater containing both chlorinated compounds and non-chlorinated compounds such as benzene, toluene, acetone and tetrahydrofuran. In the presence of methane oxidizing bacteria, extensive biodegradation of both chlorinated and non-chlorinated chemicals was observed. Biodegradation was also demonstrated in a saturated soil environment. A laboratory aquifer simulator was constructed to model the design of a proposed in situ treatment system which required the recirculation of contaminated groundwater through the aquifer. Trans-1,2-dichloroethylene (trans-1,2-DCE) was chosen as the test compound since it was rapidly biodegraded and produced an immediate product during methanotrophic biotransformation. The intermediate has been identified as trans-1,2-DCE epoxide and is readily identified during the same GC analysis used for the parent compound. The epoxide is chemically unstable with a half-life of 30 hours. These experiments showed that when methane was added to the aquifer simulator trans-1,2-DCE rapidly disappeared and the epoxide intermediate appeared immediately. The appearance of the intermediate is evidence of the in situ biodegradation in a saturated soil environment. A portion of a contaminated groundwater plume has been defined and will be treated with methane, mineral nutrients and oxygen to simulate growth of methane oxidizing bacteria. (See also W89-01530) (Author's abstract)
W89-01542

FATE AND TRANSPORT OF RESIDUAL HYDROCARBON IN GROUNDWATER: A CASE STUDY,
Shell Oil Co., Houston, TX.
For primary bibliographic entry see Field 5B.
W89-01543

ESTIMATES OF CONCENTRATIONS OF SOLUBLE PETROLEUM HYDROCARBONS MIGRATING INTO GROUND WATER FROM CONTAMINATED SOIL SOURCES,
New Jersey Dept. of Environmental Protection, Trenton. Div. of Hazardous Site Migration.
For primary bibliographic entry see Field 5B.
W89-01562

REMEDIATION OF GROUND-WATER CONTAMINATION RESULTING FROM THE FAILURE OF A CLASS I INJECTION WELL: A CASE HISTORY,
Louisiana Dept. of Natural Resources, Baton Rouge. Injection and Mining Div.
B. Walter.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 357-379, 11 fig, 10 ref.

Descriptors: *Injection wells, *Disposal wells, *Waste disposal, *Groundwater pollution, *Biodegradation, *Water pollution treatment, Louisiana, Deep wells, Liquid wastes, Monitoring, Test wells, Water pollution treatment, Organic wastes, Hazardous wastes, Detroit River Formation.

In 1960 an injection well was completed for disposal of waste water generated by a petroleum refinery in the New Orleans, Louisiana area. The injected waste stream contained primarily phenols, hydrocarbons, and spent caustic. The well was perforated for disposal into a sand approximately 2000 feet deep. Although the well was completed with a backwash tubing, disposal was directly down the casing. In 1980 injected fluids were discovered coming to the surface around the well. Integrity testing found leaks in the casing between 140 and 212 feet below land surface. Upon installation of a monitoring-well network in 1982, injected wastes were found in an adjacent shallow sand extending westward approximately 150 feet. Emplacement of additional monitor wells in the only heavily pumped aquifer in the New Orleans area, some 700 feet deep, found no evidence of contamination. Since 1982, some 250,000 barrels of water have been removed from the contaminated sand. Contaminant levels of phenols, the primary contaminant indicator, have dropped from a high of 1600 mg/l in July 1982 to 13 mg/l in August 1985 in the monitor well showing the highest initial contamination. Consideration is being given to enhancement of the native bacteriological degradation by air and/or nutrient injection. The case history is unique in that the chronology covers a period of time which includes both pre- and post-regulatory compliance with respect to permitting, monitoring, reporting, inspection and testing of injection wells. (See also W89-01564) (Author's abstract)
W89-01581

EVALUATION OF CONFINING LAYERS FOR CONTAINMENT OF INJECTED WASTEWATER,
Missouri Univ.-Rolla. Dept. of Geological Engineering.
For primary bibliographic entry see Field 2F.
W89-01584

HYDRAULIC BARRIERS IN SOIL AND ROCK.
For primary bibliographic entry see Field 8D.
W89-01612

SLURRY CUTOFF WALLS: APPLICATIONS IN THE CONTROL OF HAZARDOUS WASTES,
Geo-Con, Inc., Pittsburgh, PA.
C. R. Ryan.
IN: Hydraulic barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 9-23, 15 fig.

Descriptors: *Slurry walls, *Cutoff walls, *Water pollution prevention, *Seepage control, *Hazardous wastes, *Leachates, Soil mechanics, Oil spills, Polychlorinated biphenyls, Landfills, Phenols, Dewatering, Methane, Water pollution control, Cleanup operations.

Slurry cutoff walls are nonstructural barriers constructed to intercept and impede the flow of fluids underground. There are two basic types of slurry cutoff walls, soil-bentonite (SB) and cement-bentonite (CB). Depending on the nature of the project, either method may have some technical or economic advantage over the other. In both cases, a narrow trench is excavated into the ground using a backhoe or other more specialized equipment. The trench is prevented from collapsing by keeping it full at all times with bentonite slurry similar to drilling mud. In the case of SB walls, the trench is subsequently backfilled with a mixture of soil and bentonite slurry that forms the permanent impervious cutoff wall. With the CB method, cement is added to the slurry, which later sets up, forming the permanent seepage barrier. Slurry cutoff walls are being used in an increasing variety of applications to provide a barrier to the lateral underground flow of various fluids. Principal applications are site dewatering, underground pollution control, and seepage barriers under dams. Case studies are used to provide examples of recent applications in the control of leaching hazardous wastes. Projects cited include: containment of soil seeping through a reservoir abutment; cleanup of a polychlorinated biphenyl (PCB) contaminated site; containment of leachates and methane gas migration from a sanitary landfill site; and cleanup of a site with spilled phenols. All of the examples were selected because of the unusual conditions under which they were constructed or because of the dramatic evidence of results. (See also W89-01612) (Author's abstract)
W89-01613

SUBSURFACE POLLUTION CONTAINMENT USING A COMPOSITE SYSTEM VERTICAL CUTOFF BARRIER,
Wehran Engineering Corp., Middletown, NY.
G. W. Druback, and S. V. Arlotta.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 24-33, 5 fig.

Descriptors: *Water pollution control, *Cutoff walls, *Leachates, *Seepage control, *Slurry walls, Soil mechanics, Polymers, Groundwater movement, Landfills, New Jersey, Bentonite, Trenches, Water pollution prevention, Sand.

A new concept for constructing a vertical impermeable barrier to prevent the migration of polluted groundwater or leachate from a contaminated site or waste disposal area is presented. The composite system is a hybrid cutoff wall constructed with high density polyethylene (HDPE) and sand backfill and is installed using the slurry trench construction method. When installed, a very low permeability, composite, vertical barrier is established with unique engineering properties, including improved chemical resistance, leak detection, and groundwater migration control. A full-scale construction test project of the system was performed at an existing sanitary landfill in New Jersey in the fall of 1982 to demonstrate the overall fabrication and construction procedures. The test project was conducted in three phases: (1) the excavation of a trench filled with the bentonite slurry mixture through the landfill waste; (2) the cutting and seaming of HDPE material to form an envelope; and (3) the placement of the envelope and subsequent backfilling with sand and water. The success of the operation under often difficult conditions proved that the theory and construction concept of the composite system barrier can be utilized to construct a cutoff wall. Useful information for future applications at contaminated sites was gained. (See also W89-01612) (Author's abstract)
W89-01614

THIN SLURRY CUTOFF WALLS INSTALLED BY THE VIBRATED BEAM METHOD,
Purdue Univ., Lafayette, IN. School of Civil Engineering.
G. A. Leonards, F. Schmednecht, J. L. Chameau, and S. Diamond.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 34-44, 5 fig, 1 tab.

Descriptors: *Slurry walls, *Cutoff walls, *Seepage control, *Slurries, *Soil mechanics, Construction, Cements, Bentonite, Permeability, Soil properties, Piezometers.

Thin slurry walls installed by vibrating a beam into the ground and injecting a suitable slurry as it is withdrawn have been used successfully and economically in a variety of applications, most notably as permanent seepage cutoffs, a means of temporarily controlling groundwater during construction, and a device for containment of toxic wastes. The equipment and construction techniques for installing the cutoff, and details of various types of slurries suitable for different applications are described. Recent development and improvements in the electrical and mechanical systems have made the driver-extractor a much more versatile and reliable machine. The crawler crane mainly hoists the weight of the vibrator, leads, and beam, while the vibrator guiding leads maintain successive beam penetrations in the same plane. The injection beam is a standard wide flange beam section with sufficient rigidity to maintain vertical straightness without bowing under the dead weight and forces of the vibrator. Positive displacement pumps can be used effectively to pump slurry directly into the injection beam up to a distance of 762 m. Two distinct families of slurry materials have been used, based respectively on portland cement-bentonite formulations and on patented formulations involving asphalt emulsions. Field and laboratory tests were conducted to determine the variation in effective permeability of slurry walls installed at sharp inclinations (up to 45 degrees); to check the continuity of vertical and inclined walls, especially at intersections of the wall segments; to determine the variation in thickness of the walls; and to develop expertise in the construction of inclined walls. Results of pumping tests and trough examination showed that battered slurry walls can be constructed in sandy soil to provide satisfactory seepage barriers. Except for the upper 0.6 to 0.9 m of wall, a continuous cutoff with an overall effective permeability of the order of .000002 cm/s was provided. (See also W89-01612) (Author's abstract)
W89-01615

EVALUATION OF TWO METHODS FOR CONSTRUCTING VERTICAL CUTOFF WALLS AT WASTE CONTAINMENT SITES,
American Colloid Co., Skokie, IL.
C. P. Jepsen, and M. Place.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 45-63, 9 fig, 14 ref.

Descriptors: *Cutoff walls, *Waste disposal, *Water pollution prevention, *Slurry walls, *Seepage control, Bentonite, Cements, Permeability, Trenches, Construction, Comparison studies, Slurries, Water pollution control, Grouting.

Two methods of constructing vertical cutoff walls for the control of migrating waste materials - the conventional slurry trenching method and the vibratory beam method - are compared. Conventional slurry trenching is a method by which a continuous trench is excavated under a slurry consisting primarily of sodium bentonite and water. Following excavation, the trench is backfilled with a mixture of excavated soil, bentonite, and water to form a continuous soil-bentonite cutoff wall. A variation of this technique is the cement-bentonite slurry trenching method in which a slurry consisting of cement, bentonite, and water is used. The vibratory beam injection method involves penetration, to a preselected depth, of a wide flange beam containing integral grout injection equipment. As the beam is vibrated into position, soil consolidation and displacement occurs. After reaching the desired depth, the beam is vibrated up out of the penetration, leaving a consolidation void which is pressure-grouted full with a grout that hardens in place. Successive beam penetrations are overlapped to form the cutoff wall. The conventional slurry trenching method provides for more positive quality control in two ways: (1) excavation allows for inspection of all trench dimensions, and (2) removal of material from the trench allows for visual inspection of the suitability of the excavated aquaclude material into which a trench is being keyed. The vibratory beam injection method must settle for above ground indications of conditions below. Beam alignment tolerances and beam deflections limit the effectiveness of this method, especially at penetration depths greater than 14.1 m. (See also W89-01612) (Geiger-PTT)
W89-01616

INFLUENCE OF INORGANIC PERMEANTS UPON THE PERMEABILITY OF BENTONITE,
International Minerals and Chemical Corp., Detroit, MI.
G. Alther, J. C. Evans, H. Y. Fang, and K. Witmer.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 64-74, 6 fig, 1 tab, 4 ref.

Descriptors: *Water pollution control, *Permeability, *Seepage control, *Bentonite, *Cutoff walls, Waste management, Polymers, Cations, Anions, Clays, Soil properties, Slurries, Salts.

A total of 16 inorganic aqueous solutions were utilized as permeants to determine their effects upon the permeability of both contaminant resistant (polymerized) bentonite and untreated bentonite. Of the aqueous solutions tested, those with potassium cations or chloride anions or both induced the largest permeability increases with increasing electrolyte concentration. Conversely, solutions with sodium cations or carbonate anions had the least impact upon the permeability of bentonite. It was also observed that doubly charged cations have a greater initial effect on the permeability than do singly charged cations. Furthermore, a saturation limit was in evidence for doubly charged cations, indicating that beyond certain concentrations the further addition of the soluble salts had only limited additional impact upon the permeability. For selected bentonite-contaminant combinations, slurry cracking pattern tests were conducted. A correlation between the permeability changes and the results of the cracking pattern tests was demonstrated. It is concluded that the character of the solute anions, as well as the primary cations, affect the permeability of bentonite clays. Further, the Gouy-Chapman model of diffuse double layer was found to be generally consistent with the test data. (See also W89-01612) (Author's abstract)
W89-01617

EFFECTS OF VARIOUS LIQUIDS ON CLAY SOIL: BENTONITE SLURRY MIXTURES,
Brown (K.W.) and Associates, Inc., College Station, TX.
For primary bibliographic entry see Field 8D.
W89-01619

PERMEABILITY TESTING ON CLAYEY SOIL AND SILTY SAND-BENTONITE MIXTURE USING ACID LIQUOR,
Woodward-Clyde Consultants, Englewood, CO.
For primary bibliographic entry see Field 8D.
W89-01622

DESIGN AND TESTING OF A COMPACTED CLAY BARRIER LAYER TO LIMIT PERCOLATION THROUGH LANDFILL COVERS,
Notre Dame Univ., IN. Dept. of Civil Engineering.
J. A. Mundell, and B. Bailey.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 246-262, 12 fig, 2 tab, 17 ref.

Descriptors: *Liners, *Water pollution prevention, *Clays, *Cutoff walls, *Landfills, *Seepage control, Linings, Soil mechanics, Permeability, Testing procedures, Soil compaction, Soil properties.

The design and testing of a compacted clay barrier layer to restrict vertical percolation through landfill covers is discussed. General relationships between compaction water content, dry unit weight, and permeability related to changes in soil fabric due to varying compaction conditions are reviewed. Laboratory testing programs to evaluate the degree of imperviousness capable of being achieved in the filed for a given soil type are outlined, and a case study of the design and testing of a compacted clay barrier over a landfill is presented. Based on the results of the laboratory testing program prior to construction, it was determined that a design permeability of from 1 to 5 times 10 to the minus 8th power cm/second could be achieved by controlling the minimum dry unit weight to greater than 95% of the standard Proctor dry density and the compaction water content to greater than 1% wet of the line of optimums. Results of laboratory permeability testing on undisturbed ring and block samples taken from the landfill barrier layer indicated that an average permeability of 2 times 10 to the minus 8th power cm/second had been achieved. (See also W89-01612) (Author's abstract)
W89-01629

PERMEABILITY OF FLY ASH AND FLY ASH-SAND MIXTURES,
Wisconsin Power and Light Co., Madison, WI.
K. D. Vesperman, T. B. Edil, and P. M. Berthouex.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 289-298, 5 fig, 3 tab, 5 ref.

Descriptors: *Permeability, *Fly ash, *Sand, *Liners, *Water pollution prevention, *Landfills, Hydraulic gradient, Linings, Soil compaction, Soil properties, Soil porosity.

In an experimental program aimed at evaluating the potential of fly ash for use in liners, permeability tests were performed on two pozzolanic fly ashes from western U.S. coal sources compacted at varying densities and mixed in varying percentages with a quartz sand. Permeability testing was performed in a falling head, flexible membrane, triaxial cell permeameter. A back pressure of 380 kPa and a hydraulic gradient of 10 to 20 were applied to the permeability specimens. The two pozzolanic

fly ashes exhibit different degrees of self-cementation, which causes a dramatic influence on the resulting permeability values. The highly self-cementing fly ash exhibits nearly a full three orders of magnitude lower permeability than the less self-cementing fly ash. Increasing density, while not as important as the coal source, decreases permeability in both types of fly ash on the order of about half a magnitude. Moisture content is also an important factor since it controls the extent of cementation as well as compaction density. Increasing percentages of fly ash in the mixtures decreases the permeability up to a limiting value when the volume of fly ash and water added exceeds the available pore space between the sand grains; for instance, the mixture of 40% self-cementing fly ash and 60% sand exhibits essentially the same permeability as the 100% fly ash specimen. The study indicates that the addition of pozzolanic fly ash to an otherwise highly permeable soil results in a dramatic reduction in permeability. The self-cementing fly ash exhibits 1,000 to 10,000 folds of permeability reduction with final permeabilities of less than .000001 mm/second and seems quite suitable for liner applications. (See also W89-01612) (Author's abstract)
W89-01632

SOIL-CEMENT LINERS,
Portland Cement Association, Skokie, IL. Energy and Water Resources Dept.
For primary bibliographic entry see Field 8D.
W89-01633

HAZARDOUS AND INDUSTRIAL SOLID WASTE TESTING AND DISPOSAL: SIXTH VOLUME.
For primary bibliographic entry see Field 7B.
W89-01634

LOW-COST DATA MANAGEMENT FOR PROTECTION OF GROUND-WATER RESOURCES: THE IMPORTANCE OF QUALITY ASSURANCE,
Louisiana Dept. of Environmental Quality, Baton Rouge.
For primary bibliographic entry see Field 7C.
W89-01641

PRINCIPLES OF BIORECLAMATION OF CONTAMINATED GROUND WATER AND LEACHATES,
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
G. F. Parkin, and C. R. Calabria.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 151-173, 5 fig, 2 tab, 41 ref.

Descriptors: *Leachates, *Biodegradation, *Biological treatment, *Groundwater pollution, *Water pollution treatment, Recycling, Hazardous wastes, Water treatment, Bacteria, Wastewater treatment.

Improper disposal of hazardous wastes has resulted in contamination of saturated and unsaturated subsurface materials (the soil/rock/groundwater system) and production of leachates. One of the least appreciated and least applied remedial treatment techniques for these contaminated materials is biological treatment. Such treatment can result in the destruction of hazardous contaminants and may be cheaper than other alternatives. Efficient bioreclamation can occur when a proper, uniform environment for the bacteria, adequate contact between the contaminated materials and the bacteria, and sufficient time to effect the degradation are provided. Maintaining the proper environment (aerobic, anaerobic, or both) includes making sure biodegradable organics are present in sufficient quantity, paying attention to microbial nutrition, keeping the pH in a suitable range, and ensuring that the bacteria can adapt to the presence of toxic substances. Selection of the bioreclamation technique to be used depends on the nature and concentration of the contaminants. The choices for above-ground treatment are suspended-growth and attached/entrapped-growth reactors. Attached/entrapped-growth systems have significant advantages for treating hazardous wastes. The three basic options for in-situ treatment are (1) enhancement of indigenous bacteria, (2) extraction-injection-recycle, and (3) creation of a biologically active barrier. Patience and an appreciation for the keys to efficient biological treatment are required to make these options work. (See also W89-01634) (Author's abstract)
W89-01644

DEVELOPING GUIDES FOR SAMPLING AND ANALYSIS OF GROUND WATER,
Dow Chemical Co., Baton Rouge, LA. Louisiana Div.
For primary bibliographic entry see Field 7A.
W89-01653

GLOUCESTER PROJECT: A STUDY IN ORGANIC CONTAMINANT HYDROGEOLOGY,
Department of the Environment, Ottawa (Ontario). River Road Environmental Technology Center.
For primary bibliographic entry see Field 5B.
W89-01666

ACCELERATING RECOVERY OF THE MERCURY-CONTAMINATED WABIGOON/ENGLISH RIVER SYSTEM.
Ontario Ministry of the Environment, Thunder Bay (Ontario).
J. W. Parks, and A. L. Hamilton.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 159-188, 13 fig, 4 tab, 64 ref.

Descriptors: *Mercury, *Wabigoon River, *English River, *Ecological effects, *Water pollution treatment, *Water pollution effects, Methyl mercury, Fish, Partitioning, Suspended sediments, Inorganic compounds, Water temperature, Bioaccumulation, Ontario, Fate of pollutants, Clay.

Mercury levels (essentially methyl mercury - MeHg) in sportfish in a 250 km section of the Wabigoon-English River system remain seriously elevated as a result if the discharge of approximately 10 tons of inorganic Hg from a chlor-alkali plant at Dryden, Ontario, which occurred primarily between 1962 and 1970. The discharges resulted in elevated Hg concentrations in water, sediments and biota. Field studies in 1978-81 suggest that partitioning of inorganic and MeHg between surface sediment, water and suspended particles occurs within days. MeHg levels in water were partitioned with total (essentially inorganic) Hg. Temperature affects both Hg and MeHg levels in water; concentrations fluctuated seasonally by an order of magnitude at some sites. Hg in contaminated surface sediments is almost certainly the primary source of the mercury now entering the water and biota in this contaminated watercourse. Mercury levels in biota decline less dramatically with distance downstream of Dryden than Hg concentrations in sediments. Natural erosion, resuspension and sedimentation processes have helped to reduce the amount of Hg in the active layer at the sediment/water interface and the most effective means of accelerating the recovery of the system will probably involve measures to accelerate these natural processes. Enclosure experiments, regional surveys and geochemical studies all provide evidence that the biological uptake of upstream anthropogenic Hg loadings at any given site would likely be reduced dramatically by the continuous addition of modest quantities of pristine clay sediment. The quantities contemplated, when resuspended, would result in suspended solids concentrations on the order of 15-25 ppm, a value higher than for most shield waters but well within the range of many other watercourses in North America. (See also W89-01714) (Lantz-PTT)
W89-01730

CONTAMINATED SEDIMENTS IN THE ELBE ESTUARY: ECOLOGICAL AND ECONOMIC PROBLEMS FOR THE PORT OF HAMBURG,
Behoerde fuer Wirtschaft, Verkehr und Landwirtschaft, Hamburg (Germany, F.R.).
For primary bibliographic entry see Field 5C.
W89-01731

SEDIMENT-ASSOCIATED CONTAMINANTS: AN OVERVIEW OF SCIENTIFIC BASES FOR DEVELOPING REMEDIAL OPTIONS,
Technische Univ. Hamburg-Harburg (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W89-01734

PROTOCOL FOR THE SELECTION OF PROCESS-ORIENTED REMEDIAL OPTIONS TO CONTROL IN SITU SEDIMENT CONTAMINANTS,
International Joint Commission-United States and Canada, Windsor (Ontario).
R. L. Thomas.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 247-258, 1 fig, 2 tab, 10 ref.

Descriptors: *Sediment contamination, *Water pollution treatment, Water pollution control, Dredging, Path of pollutants, Remedial action, Monitoring.

The role of sediments in the adsorption and desorption of toxic elements and compounds is well known. By these processes, elements are moved from their points of origin to a final sink. Areas of intense human activity are characterized by the production of a large array of toxic materials, many of which may be found in the sediments of a variety of areas in the world. It has been shown, even when sources of elements and compounds have been eliminated, that the recovery rate of such areas in non-existent or slow due to the direct effects of the polluted sediment on the associated ecosystem. This paper briefly discusses the problem and discusses a number of remedial options and their selection. The options include dredging, leaving in place or a series of inactivation methods to be applied in situ. These in situ methods include covering, ploughing and acceleration of the rate of sediment accumulation. Following any remedial action, monitoring must continue to ensure that the system is recovering in a manner that achieves the specified objectives of the remedial plan. (See also W89-01714) (Author's abstract)
W89-01735

TRADEOFFS BETWEEN STREAM REGULATION AND POINT SOURCE TREATMENTS IN COST-EFFECTIVE WATER QUALITY MANAGEMENT,
Tennessee Valley Authority, Norris. Water Systems Development Branch.
G. E. Hauser, and R.J. Ruane.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 329-338, 5 fig, 1 tab, 7 ref.

Descriptors: *Water quality control, *Regulated flow, *Wastewater treatment, *Streams, *Water quality management, *Costs, Dissolved oxygen, Water pollution sources, Flow profiles, Fort Patrick Henry Dam.

This project supports a joint study by the U.S. EPA and the Tennessee Valley Authority (TVA) designed to identify the cost-effectiveness of different improvement strategies for obtaining various dissolved oxygen (DO) levels. The study was also conducted in conjunction with TVA efforts to further enhance water quality downstream from TVA dams. The cooperative efforts of these agencies resulted in initiation and completion of an exploratory study of water quality improvement strategies for a 30-km reach of the Holston and South Fork Holston Rivers near Kingsport, Tennessee. Using DO as the primary management variable, the following improvement strategies were explored: (1) further restriction on discharge of oxygen-demanding wastes; (2) varying flow re-

gimes with Fort Patrick Dam; (3) turbine aeration at Fort Patrick Henry Dam; (4) instream oxygen injection; and (5) combinations of the aforementioned. (See also W89-01736) (Lantz-PTT)
W89-01758

WATER TEMPERATURE CONTROL AND AREAL OXYGEN CONSUMPTION RATES AT A NEW RESERVOIR, AND THE EFFECTS ON THE RELEASE WATERS,
Army Engineer District, Portland, OR.
For primary bibliographic entry see Field 2H.
W89-01759

INCREASING THE OXYGEN CONTENT OF THE KALAJOKI RIVER,
National Board of Waters, Helsinki (Finland).
E. Lakso.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 353-362, 7 fig, 1 tab, 8 ref.

Descriptors: *Oxygen, *Kalajoki, *Water quality management, *Rivers, *Finland, Seasonal variation, Aeration, Thermal stratification.

In Finland, the need to raise the oxygen content of waters is most evident in late winter when the ice cover prevents the water from receiving oxygen from the air. In Central and Southern Finland, the watercourses become ice-bound in November-December, and the ice melts in April-May. Although the water temperature in winter is only 0-4 C, the pollution loads put on the systems cause rapid consumption of the available oxygen. Despite wastewater treatment, some waterways or parts of watercourses have such a high loading factor that the oxygen content drops too low for the use of these waters for fisheries or for some other purposes. Low oxygen concentrations may also cause problems during early autumn, usually when large amounts of treated wastewater are discharged into relatively small streams. Temporary lowering of the oxygen content of the water has also been observed as the result of algal blooms. The probability of these occurring in Western Finland is not very great, due to the fairly cold climate as well as the characteristic brown color of the waters there. As the result of the thermal stratification which occurs in lakes and reservoirs, oxygen depletion problems generally occur in the bottom layers. The oxygen of the hypolimnion has been improved by pumping surface water rich in oxygen into the lower layers. In some instances, the hypolimnion has also been aerated. The oxygen content of river water has been improved by aerating at overflow dams and, in the Kaljoki River, at the powerplants on an experimental basis. The oxygen level has not been raised through the use of pure oxygen, except for a few very short trial runs as the use of oxygen is expensive. (See also W89-01736) (Lantz-PTT)
W89-01760

WILDLIFE PROTECTION, MITIGATION, AND ENHANCEMENT PLAN, PALISADES PROJECT,
Idaho Dept. of Fish and Game, Boise.
R. C. Martin, and H. J. Hansen.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009911. Price codes: A06 in paper copy, A01 in microfiche. DOE Report No. DOE/BP/62775--1, November 1986. 110p, 1 fig, 14 tab, 62 ref. DOE Contract DE-AI79-86BP62775.

Descriptors: *Environmental protection, *Wildlife, *Conservation, *Palisades Reservoir, *Idaho, *Wyoming, *Legislation, Reservoirs, Ecosystems, Ecological distribution, Habitats, Bald eagle, Mule deer, Elk, Ducks, Geese, Waterfowl, Mink, Warblers, Grouse, Falcons, Birds.

Under direction of the Pacific Northwest Electric Power Planning and Conservation Act of 1980 and the subsequent Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program, projects have been developed in Idaho and Wyoming to mitigate the losses of wildlife habitat and annual production due to the development and operation of the Palisades Project. A modified Habitat Evaluation Procedure (HEP) was used to assess the benefits of the preferred mitigation plan to wildlife. The interagency work group used the target species Habitat Units (HU's) lost with inundation of the reservoir area as a guideline during the mitigation planning process, while considering needs of wildlife in eastern Idaho and western Wyoming. A total of 37,068 HU's were estimated to be lost as a result of the inundation of the Palisades Reservoir area. Through a series of protection/enhancement projects, the preferred mitigation plan will provide benefits of an estimated 37 66 HU's. Target species to be benefited by this mitigation plan include bald eagle, mule deer, elk, mallard, Canada goose, mink, yellow warbler, black-capped chickadee, ruffed grouse, and peregrine falcon. (Author's abstract)
W89-01771

SIMPLE IN-STREAM TEST OF LABORATORY FINDINGS THAT NTA PROTECTS FISH AND INVERTEBRATES AGAINST COPPER AND ZINC,
Guelph Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W89-01794

SUPPLEMENTARY REPORT OF THE FLATHEAD RIVER INTERNATIONAL STUDY BOARD.
International Joint Commission-United States and Canada, Columbus, OH.
July 1988. 24p, 1 fig, 4 ref.

Descriptors: *Water pollution prevention, *Environmental effects, *Flathead River, *Coal mining, Water quality, Water quantity.

In February 1984, the British Columbia government granted Sage Creek Coal Limited approval-in-principal for a 2.2 million tons (2.4 million tons) per year thermal coal mine located 10 km upstream from the International boundary on Howell and Cabin Creeks, tributaries of the Flathead River. The mine plan is based on 21 years of mining at this rate. Coal reserves, however, exist for a further 20 years of mining at the same rate. The effects of the mine on Cabin and Howell Creeks at and immediately downstream of the mine site are difficult to predict because of the complex interrelationships between surface and groundwater hydrology. Additional information regarding possible mitigative measures, study needs, and provincial government regulation, requested in a letter to the Board from the Commission is provided based on information given by the various divisions of the Commission. (See also W89-01808) (Lantz-PTT)
W89-01809

COMPUTER MODELS IN ENVIRONMENTAL PLANNING,
Ohio State Univ., Columbus. Dept. of City and Regional Planning.
For primary bibliographic entry see Field 6A.
W89-01823

PROTECTING AQUATIC RESOURCES: AN ECOLOGIST'S PERSPECTIVE,
Oak Ridge National Lab., TN. Environmental Sciences Div.
J. M. Giddings.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 97-104, 1 fig, 16 ref. DOE Contract DE-AC05-840R21400.

Descriptors: *Toxicology, *Water pollution prevention, *Aquatic toxicology, *Ecological effects, Model studies, Ecosystems, Bioassay, Toxicity, Chemicals.

Because natural populations are linked by a variety of ecological interactions (for example, predation and competition), the response of any particular population to chemical exposure depends on how the rest of the ecosystem is affected. Mathematical models and field experiments demonstrate that such interactions can amplify or diminish the impacts of contaminants on populations. When direct toxic effects result in persistent, significant changes in some parts of an ecosystem, other populations in the ecosystem become vulnerable to indirect effects. Protection of aquatic populations, then, requires protection of aquatic ecosystems. The threshold of persistent, significant damage to an ecosystem is a distinct discontinuity in the gradient of ecosystem response to increasing chemical exposure. The safe level of exposure for an aquatic ecosystem can be determined experimentally using microcosms or field enclosures. It is hypothesized that safe exposure levels for ecosystems are usually near the lower end of the chronic toxicity range for single species. Data on chemical effects in ecosystems are needed in order to calibrate standard bioassay and to verify the accuracy of methods for extrapolating from bioassay results to nature. (See also W89-01892) (Author's abstract)
W89-01900

ARE THE 'GUIDELINES FOR DERIVING NUMERICAL NATIONAL WATER QUALITY CRITERIA FOR THE PROTECTION OF AQUATIC LIFE AND ITS USES' BASED ON SOUND JUDGMENTS,
Environmental Research Lab.-Duluth, MN.
C. E. Stephan.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 515-526, 2 tab, 21 ref.

Descriptors: *Toxicology, *Aquatic toxicology, *Standards, *Water quality control, *Aquatic life, Ecosystems, Bioaccumulation, Hazard assessment.

Until recently, procedures used to derive water quality criteria for aquatic life were not well defined and few principles were identified. On 28 November 1980 the EPA published 'Guidelines for Deriving Water Quality Criteria for the Protection of Aquatic Life and Its Uses' in the Federal Register. These have been subsequently revised and renamed 'Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Life and Its Uses' and are referred to as the 'National Guidelines.' In addition, guidelines have been developed for deriving site-specific criteria either by modifying national criteria or by using other appropriate information. Procedures for deriving water quality criteria and for assessing hazard to aquatic life have many similarities because both make use of information from many areas of aquatic toxicology. In addition, both assume that the science has developed sufficiently that these activities are feasible and desirable and that appropriate rationales are available for making necessary decisions concerning various technical issues. (See also W89-01930) (Author's abstract)
W89-01962

HOW REPRESENTATIVE ARE THE DATA SETS USED TO DERIVE NATIONAL WATER QUALITY CRITERIA,
EA Engineering, Science, and Technology, Inc., Northbrook, IL. Midwest Regional Office.
G. Seegert, J. A. Fava, and P. M. Cumbie.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 527-537, 4 fig, 2 tab, 13 ref.

Descriptors: *Toxicology, *Databases, *Water quality, *Standards, *Data interpretation, *Aquatic toxicology, Toxicity, Minnows, Bluegills, Daphnia.

One of the key assumptions implicit in developing national water quality criteria is that the data base used to derive the criteria includes data from a reasonable cross section of the aquatic communi-

ties to be protected. This requires testing not only a large number of species but those species that represent a variety of taxonomic and functional groups. Examination of the national toxicity data base indicated that the toxicity data which it contains does not meet these assumptions because (for 21 priority pollutants) 40% of the data are on a few regularly tested species such as bluegill and fathead minnow and one quarter of the data are on only two families, Daphnidae and Salmonidae. Furthermore, for many chemicals, many of the species that have been tested are restricted to the northeastern and/or upper midwest portions of the United States. Evidence also suggests that sensitive species may be over-represented in the national toxicity data base. The net result is that there is now a great deal of data about a few species, but little or no data about the vast majority of species. Nor do the data available necessarily represent a reasonable cross section, based on sensitivities or ecological importance. The above assertions are supported here using examples from the national data base and from data bases on individual chemicals. This indicates a need for information on a wider variety of organisms in order for the national data base to be representative of the full range of sensitivities expected in the population as a whole. While it is recognized that it will not be possible to conduct tests on all species, the underlying distribution of the data base should be understood before appropriate statistical methods can be developed to derive national water quality criteria for the protection of aquatic life. (See also W89-01930) (Lantz-PTT)
W89-01963

AQUATIC HAZARD EVALUATION PRINCIPLES APPLIED TO THE DEVELOPMENT OF WATER QUALITY CRITERIA,
Monsanto Co., St. Louis, MO.
R. A. Kimerle, A. F. Werner, and W. J. Adams.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 538-547, 5 tab, 10 ref.

Descriptors: *Toxicology, *Hazard assessment, *Water quality control, *Standards, *Aquatic toxicology, Lethal limits, Bioassays, Daphnia, Fathead minnows, Bluegill, Trout, Fish, Toxicity.

The methodology to derive a national water quality criterion requires that the acute toxicity data base contain at least eight species from eight families. The thesis investigated here is that for many chemicals, fewer species acute toxicity tests are adequate for deriving criteria and for screening chemicals to determine whether a criterion is necessary. This is especially true when the exposure concentration is expected or known to be several orders of magnitude below the acute effect concentration. An 82 chemical acute toxicity data base with an average of 9.5 species acute toxicity tests per chemical was reviewed for the relationship between the most sensitive species LC sub 50 value and LC sub 50 values for four of the most commonly tested species: Daphnia, fathead minnow, bluegill, and rainbow trout. It was concluded that for 90% and 98% of the 82 chemicals reviewed, the Daphnia and fathead minnow acute data were within one and two orders of magnitude, respectively, of the most sensitive species. The ability to predict the LC sub 50 for the sensitive species is improved if three species are used; 98% of the LC sub 50 are included with Daphnia, fathead minnow, and bluegill and 93% with algae, Daphnia, and fathead minnow. Therefore it was concluded that for many chemicals, acute tests with only two or three species are enough to determine that a water quality criterion is not needed for the chemical. (See also W89-01930) (Author's abstract)
W89-01964

ROLE OF PHYTOTOXICITY TESTS IN THE DERIVATION OF NUMERICAL NATIONAL WATER QUALITY CRITERIA,
Illinois State Water Survey, Peoria. Water Quality Section.
W. Wang.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, APril 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 548-550, 2 fig.

Descriptors: *Water quality control, *Phytotoxicity, *Standards, *Toxicology, *Toxicity, *Aquatic toxicology, Aquatic plants.

The Guidelines state that the phytotoxicity test procedure has not been well developed, yet indicate that plant species are not as sensitive to toxicity as animals. The author contents that it is too early to draw a conclusion on the sensitivity of plant toxicity tests. The objective approach for the National Guidelines to take is to encourage further studies so that a better assessment can be made when more results are available. (See also W89-01930) (Lantz-PTT)
W89-01965

EVALUATION OF A SITE-SPECIFIC WATER QUALITY CRITERION FOR PENTACHLOROPHENOL USING OUTDOOR EXPERIMENTAL STREAMS,
Environmental Research Lab.-Duluth, Monticello, MN. Monticello Ecological Research Station.
S. F. Hedtke, and J. W. Arthur.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 551-564, 1 fig, 3 tab, 17 ref.

Descriptors: *Toxicology, *Aquatic toxicology, *Water quality control, *Standards, *Pentachlorophenol, Toxicity, Bioassays, Aquatic toxicology, Ecosystems, Snails, Fish, Periphyton.

An overview of a study to evaluate a site-specific water quality criterion for pentachlorophenol (PCP) in outdoor experimental streams is presented. The site-specific criterion was calculated from acute toxicity results for eight resident species and the relationship between acute and chronic toxicity of PCP. The PCP concentration expected to protect aquatic life (30-day average criterion concentration) was < or = to 48 micrograms/L. Outdoor experimental streams were subsequently dosed continuously for 84 days at 48, 144, and 432 micrograms PCP/L. Measurements of the biological structure and ecosystem processes within the exposure streams were compared to a control system. Effects on snails were found only at 432 micrograms/L, but effects on fish, periphyton, and system metabolism were found at 432, 144, and 48 micrograms/L. The small differences between the criterion-dosed stream (48 micrograms/L) and the control stream may have been caused by PCP or interstream variation. The acceptability of this criterion concentration depends in part on the definition of protection of aquatic life and its uses. (See also W89-01930) (Author's abstract)
W89-01966

USE OF STATISTICAL INFORMATION TO IMPROVE COMPATIBILITY BETWEEN THE VARIOUS COMPONENTS OF THE WATER QUALITY BASED APPROACH,
Environmental Research Lab.-Duluth, MN.
N. A. Jaworski, and D. I. Mount.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 565-573, 10 ref.

Descriptors: *Toxicology, *Aquatic toxicology, *Water quality control, *Standards, *Statistical studies, Wastewater management, Water quality management.

During the past two decades, implementation procedures in wastewater management often resulted in a large margin of safety being incorporated into the use of water quality criteria for the protection of aquatic life and its uses. Wasteload allocation design conditions, such as the use of seven-day, ten-year low flow, gave assurances of instream concentrations well below the water quality criteria a large percentage of time. Present-day economic conditions and the increasing cost of advanced wastewater treatment are necessitating a re-examination of how water quality criteria are being used in the water quality based approach for establishing effluent limitations. The relationships between water quality criteria and other components of the water quality based approach are identified. The need for a better defined and more consistent use of statistical information is suggested not only in the development of water quality criteria but also for the entire water quality based approach. Intensity, duration, and frequency of occurrence (return period) appear to be three common statistical parameters of the six-step water quality based approach. Research is identified which, if successful, would allow water quality managers better insight in determining pollutant exposures that more adequately simulate receiving water conditions resulting from variable stream flows, wastewater discharge rates, and pollutant concentrations. (See also W89-01930) (Author's abstract)
W89-01967

ENVIRONMENTAL MANAGEMENT OF WATER PROJECTS.
For primary bibliographic entry see Field 4A.
W89-01990

ENVIRONMENTAL CONDITIONS FOR WATER RESOURCES PROJECTS,
For primary bibliographic entry see Field 6G.
W89-01991

TECHNICAL REVIEW OF THE FACTORS AFFECTING 2,4-D FOR AQUATIC USE,
For primary bibliographic entry see Field 4A.
W89-01996

TECHNICAL REVIEW OF THE FACTORS AFFECTING ENDOTHALL FOR AQUATIC USE,
For primary bibliographic entry see Field 4A.
W89-01997

TECHNICAL REVIEW OF FACTORS AFFECTING DIQUAT FOR AQUATIC USE,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 4A.
W89-01998

PROCEEDINGS OF THE 42ND INDUSTRIAL WASTE CONFERENCE.
For primary bibliographic entry see Field 5D.
W89-02006

COST ALLOCATION AT SUPERFUND SITES,
Environmental Resources Management-North Central, Inc., Deerfield, IL.
R. O. Ball, E. F. Millano, and J. W. Polich.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 15-27, 2 fig, 8 tab, 16 ref.

Descriptors: *Water pollution control, *Costs, *Cleanup operations, *Superfund, *Disposal sites, Case studies, Mathematical studies, Hazardous wastes.

A methodology to allocate cleanup costs at Superfund sites among Responsible Parties is presented. The methodology is simple, and complicated calculations are not required. The calculations can be readily using a spreadsheet format. The allocations is based upon the relative environmental impact at up to four receptors, and considers both the nature and quantity of the materials contributed to the site

by the parties. The results of a case study presented that the allocation of costs based on waste volume is unfair when the environmental impact of a generator's waste is low compared to those of other wastes, but its volume is comparatively high. Since the reason for cleanup of hazardous waste disposal sites is the impact they have (or will have) on the environment, the methodology presented here may represent a more reasonable way of allocating cleanup costs of Superfund sites among Responsible Parties, compared to a simple waste volume allocation. (See also W89-02006) (Lantz-PTT)
W89-02009

COOPERATIVE EFFORT TO REMEDIATE A HISTORICAL PCB DISPOSAL SITE,
Aluminum Co. of America, Davenport, IA. Davenport Works.
M. K. Sonksen, and D. V. Crawford.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 33-38, 2 fig, 1 tab.

Descriptors: *Cleanup operations, *Polychlorinated biphenyls, *Disposal sites, *Water pollution control, Trenches, Caps, Groundwater pollution, Water pollution prevention, Water quality control, Costs, Monitoring, Iowa.

In the period of 1981 through 1984, Alcoa, Davenport Works, spent $3.4 million to eliminate a PCB contaminated oil lagoon located next to the Mississippi River. By working closely with state and federal environmental agencies, a remedial action plant, including a collecting trench and cap and cover system, was developed that minimized the immediate environmental threat of an open lagoon and established a reasonable closure and monitoring plan. Although only future monitoring will determine the absolute success of the system, results to date look good. Groundwater data being collected under the plan will confirm the long-term effectiveness of the existing system and, if necessary, provided valuable information for future modifications or adjustments. (See also W89-02006) (Lantz-PTT)
W89-02010

DESIGN, ECONOMICS, AND OPERATION OF A BIOLOGICAL TREATMENT SYSTEM FOR KETONE CONTAMINATED GROUND AND SOLVENT RECOVERY PROCESS WATERS,
DETOX, Inc., Dayton, OH.
For primary bibliographic entry see Field 5D.
W89-02012

LEACHABILITY OF SOLIDIFIED (BA, RA)SO4 SEDIMENTS IN SIMULATED SETTLING PONDS,
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
For primary bibliographic entry see Field 5B.
W89-02013

BIODEGRADATION OF ORGANIC COMPOUNDS IN ANOXIC GROUNDWATER SYSTEMS,
Black and Veatch, Philadelphia, PA.
W. G. Wilson, and J. T. Novak.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 197-205, 7 fig, 1 tab, 4 ref.

Descriptors: *Fate of pollutants, *Groundwater pollution, *Biodegradation, *Organic compounds, Alcohols, Methanol, Hydrogen ion concentration, Nitrates, Sulfates.

Two alcohol compounds were of interest in this study, methanol and tertiary-butyl alcohol (TBA). The state of the groundwater environment and microbial population will determine the rate and pathways of biodegradation. Degradation of both methanol and TBA has been demonstrated in subsurface microcosms, but the rate of TBA removal is usually very slow. In this study microcosms were used to investigate the variations in alcohols degradation rates in groundwater systems. Also, alternative electron acceptors (nitrate and sulfate) were added to the oxygen-poor environment to determine whether anaerobic respiration might occur. The microcosms were dosed with base to determine pH effects on nitrate-dosed, sulfate-dosed, and non-amended microcosms. The non-nitrate- or sulfate-amended microcosms did not respond to increased pH with enhanced biodegradation. The highest pH treatment caused inhibition of methanol degradation rates and had little effect on TBA degradation. Addition of sulfate was generally unsuccessful in stimulating alcohols degradation. Nitrite toxicity was evident in some of the nitrate-dosed microcosms at pH 5.1. A higher pH allowed enhancement of methanol degradation to proceed, especially at pH 7 and above. Biodegradation of TBA was moderately stimulated in some pH 6.0 microcosms and all pH 8.8 microcosms. Alcohol uptake rates were calculated as one overall rate which was described by a straight line of best fit for the data points. Methanol degradation rates were generally highest in nitrate-dosed microcosms and lowest in sulfate-dosed microcosms. The TBA biodegradation rates are approximately 40 to 200 times lower than the methanol uptake rates. (See also W89-02006) (Lantz-PTT)
W89-02027

INVESTIGATION OF INGROUND BIOLOGICAL TREATMENT FOR GROUNDWATERS CONTAMINATED WITH VOLATILE ORGANIC COMPOUNDS,
Purdue Univ., Lafayette, IN. School of Civil Engineering.
R. W. Peters, W. L. Oresik, and B. Minsley.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 207-228, 6 fig, 9 tab, 28 ref.

Descriptors: *Groundwater pollution, *Volatile organic compounds, *Water pollution treatment, *Biological treatment, *Cleanup operations, Soil columns, In-situ treatment, Geohydrology, Vinyl chloride, Dichloroethane, Dichlorethylene, Trichloroethane, Soil properties, Hydrogen ion concentration.

The Kalamazoo Public Utility operates a water supply system consisting of 116 wells and 25 pump stations, providing an average of 17 mgd. One station in the system, Station No. 11, was found to have low levels of 1-5 ppb of 1,2-dichloroethane and cis-1,2-dichloroethylene. During the first quarter of 1981, the Kalamazoo Public Utilities instituted a system wide monitoring of its 15 well fields for volatile organic compounds (VOCs). Station 11 was one of two well fields found during this first round of sampling to contain VOCs. In January 1982, a third well field began to show low levels of trichloroethane contamination. Because contaminant levels had not changed during one year's monitoring at Station 11, the new contamination problem at the third well was given higher priority and on-going monitoring was maintained for Station 11. Station 11 finally was elevated in priority in late 1984, when routine sampling began to show the presence of vinyl chloride, a known carcinogen. In 1985, the Utility initiated a hydrogeologic investigation to determine the scope, source(s), and potential remedial action(s) for Station 11. The operation of the soil columns is in the early phases, so the results are very preliminary at this point in time. Previous research has shown that microbial in situ treatment is capable of degrading organic contaminants in groundwater systems. The soil is slightly alkaline in nature, low in nutrients, high in hardness, has a moderate cation exchange capacity, and consists primarily of sand. The soil should be amenable to microbial in situ treatment from all indications. The water analyses on the contaminated wells indicate the water is relatively high in hardness and alkalinity (with the majority of the alkalinity in the bicarbonate form), trace amounts of heavy metals, slightly alkaline conditions, moderate dissolved solids concentrations, and low nutrient conditions (nitrogen and phosphorus). The performance of the soil columns will continue to be monitored in this on-going study. (See also W89-02006) (Lantz-PTT)
W89-02028

ON-SITE TREATMENT SYSTEMS FOR AQUIFER RESTORATION BIOLOGICAL TREATMENT,
Geraghty and Miller, Inc., Oak Ridge, TN.
P. D. Kuhlmeier.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 229-235, 2 fig, 4 tab, 3 ref.

Descriptors: *Groundwater pollution, *Cleanup operations, *Aquifer restoration, *Water pollution treatment, *Biological treatment, Biodegradation, Anaerobic bacteria, Activated sludge, Trickling filters, Economic aspects, Aerobic bacteria, Organic compounds, Filtration.

In-situ and above-ground methods of treating contaminated groundwater are discussed. Key factors in selecting appropriate treatment technology are: pollutant characteristics, source characteristics, soil properties, and aquifer properties. The most common method of in-situ treatment involves extracting contaminated groundwater from selected wells and mixing the water with acclimated bacteria and nutrients in a short-detention-time reactor. Other methods are passive treatment in-place and biotrenches. Classical activated sludge and trickling filters processes have been employed in aerobic above-ground treatment of contaminated soils. Economics of these systems are discussed. (See also W89-02006) (Lantz-PTT)
W89-02029

EFFLUENT TOXICITY MONITORING METHODOLOGY EVALUATED FOR FIVE INDUSTRIAL DISCHARGERS,
Engineering-Science, Fairfax, VA.
For primary bibliographic entry see Field 5D.
W89-02030

WASTE REDUCTION IN ILLINOIS: AN OVERVIEW,
Illinois State Water Survey Div., Savoy. Hazardous Waste Research and Information Center.
D. D. Kraybill, and D. L. Thomas.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 321-329, 6 fig, 5 tab, 11 ref.

Descriptors: *Hazardous wastes, *Waste management, *Waste disposal, *Illinois, Management planning, Data acquisition, Recycling, Separation processes, Information exchange.

The Illinois Hazardous Waste Research and Information Center (HWRIC) has recognized that the ultimate solution to hazardous waste problems is to reduce the generation of waste at its source. The Center has therefore developed a program in Illinois to address this important issue. Components of this program are discussed, including: (1) source segregation/separation; (2) process modifications; (3) raw material substitution; (4) material recovery/recycling; (5) material exchange; (6) treatment; (7) new process equipment; and (8) corporate or management strategies. In Illinois, the quality of the data gathered to satisfy the RCRA waste minimization statement requirement leaves much to be desired from an information gathering standpoint. The two biggest problems in this regard are the rather low response rate (46%) by generators who are required to submit statements and a lack of detailed information on the statements that are submitted. (See also W89-02006) (Lantz-PTT)
W89-02037

STUDY AND IMPLEMENTATION OF WASTE MINIMIZATION AT IBM AUSTIN,
Montgomery (James M.), Inc., Pasadena, CA.
For primary bibliographic entry see Field 5E.
W89-02038

REGULATION OF TOXIC ORGANICS IN INDUSTRIAL SEWER DISCHARGES AT THE SANITATION DISTRICTS OF LOS ANGELES COUNTY,
Los Angeles County Sanitation Districts, Whittier, CA.
For primary bibliographic entry see Field 5E.
W89-02040

GEOSYNTHETICS FOR USE IN WASTE FACILITIES,
S and ME, Inc., Fairfield, OH.
J. A. Bove, and G. R. Koerner.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 393-397, 3 fig, 6 ref.

Descriptors: *Waste disposal, *Water pollution prevention, *Linings, *Landfills, *Geosynthetics, Separation, Filtration, Drainage, Moisture barriers, Containment, Design criteria.

Geosynthetics are man-made synthetics used in the improvement of soil and rock. The word 'Geosynthetics' is a generic term which collectively describes geotextiles, geomembranes, geonets, geogrids and geocomposites. It is commonly accepted that there are five functions that a geosynthetic can serve. These five functions are separation, filtration, drainage, reinforcement and moisture barrier. Depending on the application, the five functions can occur as individual functions or in combination with one another. It is the goal of a designer to prioritize the functions governing his project, and to design accordingly. Some of the geosynthetics on the market are so new that even basic physical, chemical, mechanical and hydraulic properties about them are unknown. Furthermore, such properties as long term compatibility, creep susceptibility, biological degradation and long term clogging are essential, but unknown for many of the products on the market. In lieu of these limitations, it is evident that there is enough confidence in geosynthetics at present to design and build waste containment systems using geosynthetics. Furthermore, it is believed that facilities can be built with a reasonable degree of confidence and at cost immeasurable to society as a whole. The resources of both government and industry need to be focused on long-term field and laboratory evaluation of geosynthetics if the degree of confidence is to increase. (See also W89-02006) (Lantz-PTT)
W89-02043

CLASSIFYING INDUSTRIAL SLUDGE USING A KNOWLEDGE-BASED EXPERT SYSTEM,
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
A. C. Chao, W. J. Rasdorf, and W. E. Paige.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 399-407, 8 ref, append.

Descriptors: *Wastewater treatment, *Computer programs, *Classification, *Hazardous wastes, *Expert systems, *Model studies, *Sludge, *Industrial wastewater, Waste disposal, Ignitability, Corrosion, Toxicity, Hydrogen ion concentration, Adsorption, Biodegradation, Decision making, Chemical properties, Pilot plants.

The criteria for identifying the characteristics of hazardous wastes listed in the North Carolina Hazardous Waste Management Rules and Solid Waste Management Law are used as bases by the North Carolina regulatory agencies to determine whether an industrial sludge is non-hazardous and thus can be disposed of in a municipal sanitary landfill. A knowledge-leased system for classifying industrial sludge is described. M.1 is a microcomputer-based knowledge engineering tool for building small knowledge systems with limited computational requirements. It was used to develop a prototype expert system to classify industrial sludge based on several criteria, including pH, moisture content, impurities, chemical fixation, and results solubility, adsorption, biodegradation, and other tests. The program consists of 55 rules and 69 knowledge base entries. Advantages and disadvantages of the system and plans for future development and implementation are discussed. (See also W89-02006) (Lantz-PTT)
W89-02044

WISCONSIN GROUNDWATER QUALITY STANDARDS: CAN WASTEWATER LAND TREATMENT SYSTEMS MEET THEM,
Wisconsin Dept. of Natural Resources, Madison. Div. of Environmental Standards.
For primary bibliographic entry see Field 6E.
W89-02080

INDUSTRIAL WASTES AND SOIL LEAD CONCENTRATION AS A BASIS FOR REMEDIAL OR OTHER ACTION,
Missouri Univ.-Rolla. Environmental Research Center.
For primary bibliographic entry see Field 6E.
W89-02083

TWO-STAGE BIOLOGICAL/CHEMICAL TREATMENT OF HAZARDOUS WASTE LANDFILL LEACHATE,
Technische Univ., Brunswick (Germany, F.R.).
For primary bibliographic entry see Field 5D.
W89-02094

MANGANESE TREATMENT BY TWO NOVEL METHODS AT ABANDONED COAL STRIP MINES IN NORTH ALABAMA,
Tennessee Technological Univ., Cookeville. Center for the Management, Utilization and Protection of Water Resources.
For primary bibliographic entry see Field 5D.
W89-02095

TREATMENT OF COAL ASH/MINE REFUSE LEACHATE: A CASE HISTORY,
Gilbert/Commonwealth, Inc., Reading, PA.
For primary bibliographic entry see Field 5D.
W89-02096

POLLUTION CONTROL LEGISLATION,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 6E.
W89-02100

HEAVY METALS IN WASTEWATER AND SLUDGE TREATMENT PROCESSES. VOLUME II: TREATMENT AND DISPOSAL.
For primary bibliographic entry see Field 5E.
W89-02104

OVERVIEW OF THE EFFECTIVENESS OF CANADIAN CHLOR-ALKALI MERCURY REGULATIONS,
Department of the Environment, Ottawa (Ontario).
D. W. Bissett, and I. T. McBeath.
IN: Toxic Contamination in Large Lakes. Volume I: Chronic Effects of Toxic Contaminants in Large Lakes. Lewis Publishers, Chelsea, Michigan, 1988. p 315-342, 11 fig, 5 tab, 11 ref.

Descriptors: *Water pollution control, *Mercury, *Canada, *Regulations, Water quality control, Industrial wastewater, Water pollution prevention, Aquatic environment, Chemical industry.

Canadian imports of mercury metal from 1960 to 1970 averaged 161,000 kg/yr. Back in the early 60s there was a strong upward trend with 1965 being the peak year when more than 450,000 kg were imported largely to meet inventory requirements for new and expanded chlor-alkali plants. Chlor-alkali plants in 1969-70 accounted for $> 47\%$ of the total Hg used in Canada. About 32% of the Hg emissions (about 75 tons) were accounted for by the 15 chlor-alkali plants, located primarily in Ontario and Quebec. In 1971 the Department of National Health and Welfare, in consultation with Environment Canada, issued a guideline forbidding the sale or consumption of fish containing > 0.5 micrograms/gm of Hg. In recent years, regulatory and industry actions have worked together to drastically reduce loadings to levels where further reductions would be technologically difficult. The levels of Hg in fish taken from waters near chlor-alkali wastewater outfalls (and previous outfalls) have shown a dramatic decrease due to the significant reduction in Hg discharges. Regulation of Hg uses, discharges and emissions from chlor-alkali plants has had a demonstrated impact on reducing Hg levels in aquatic life in many areas in Canada. (See also W89-02121) (Lantz-PTT)
W89-02135

FISHERIES MANAGEMENT, WATER QUALITY AND ECONOMIC IMPACTS: A CASE STUDY OF LAKE KINNERET,
Kinneret Limnological Lab., Tiberias (Israel).
For primary bibliographic entry see Field 8I.
W89-02138

UNITING HABITAT QUALITY AND FISHERY PROGRAMS IN THE GREAT LAKES,
Great Lakes Fishery Commission, Ann Arbor, MI.,
C. M. Fetterolf.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 85-100, 1 fig, 20 ref.

Descriptors: *Water quality control, *Great Lakes, *Fisheries management, *Management planning, Fisheries, Environmental protection, Regulations, Water management, Lakes, Public participation, Public policy.

Despite the remarkable recoveries of Great Lakes fisheries since the 1950s and water quality since the 1970s, many of today's fishery problems are related to environmental conditions. Recognizing the public's resource must receive full consideration in the present and proposed uses of the lakes, in 1981 the 12 agencies with mandated responsibility for the welfare of Great Lakes fisheries developed and signed a Joint Strategic Plan for management of Great Lakes fisheries under the aegis of the Great Lakes Fishery Commission (GLFC). The four fundamental strategies involve consensus, accountability, environmental management and management information. Four strategic procedures of the plan were designed to aid in coordinating environmental and fishery agency management efforts into a complementary process: (1) referral of environmental issues which impede achievement of fishery objectives to the GLFC; (2) representation by the GLFC in such issues to the most appropriate body; (3) identification of fishery agency plans to achieve environmental objectives; and (4) establishment of a Habitat Advisory Board to assist lake committees and the GLFC in environmental issues. In 1986 the Habitat Advisory Board added to the Strategic Plan a component for the protection, rehabilitation and enhancement of habitat required to ensure accomplishment of fishery management objectives. The fish habitat component emphasizes five areas: information, legal, working arrangements, intervention/advocacy, and public participation. Fish are of central interest to the remediation and rehabilitation initiatives underway throughout the Great Lakes. For fish habitat management and planning to be successful, a web of involvement must be developed at all levels of responsibility across agency and jurisdictional boundaries. The habitat needs for fish communities must be decided by fishery managers, and consensus on program objectives needs to be developed among the many related agencies. Optimum results can only be achieved by uniting habitat quality and fishery programs in both the planning and operational stages. (See also W89-02137) (Author's abstract)
W89-02141

LAKE ORTA (N. ITALY): RECOVERY AFTER THE ADOPTION OF RESTORATION PLANS,
Istituto Italiano di Idrobiologia, Novara.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michi-

gan, 1988. p 101-130, 4 fig, 4 tab, 29 ref.

Descriptors: *Lake Orta, *Italy, *Lake restoration, *Water pollution treatment, *Water pollution control, *Water quality control, Industrial wastewater,Cleanup operations, Nitrogen, Nitrates, Nitrites, Heavy metals, Chemical analysis.

Heavy industrial pollution (copper and ammonium sulfate) from a rayon factory was responsible for the disappearance of almost all forms of life in the lake since the late twenties. The in-lake N-NH4 oxidation produced a gradual N-NO3 accumulation and a progressive strong decrease of pH down to values around 4. The copper concentration peaked at about 100 micrograms/L in the mid-sixties, when additional sources of heavy metals (Cu, Zn, Cr) i.e. several new metal plating factories were set up on the lake western shores. Toxicity texts with rainbow trout indicated that Cu at the prevailing very low pH was the major cause of absence of pelagial fish in the lake. In 1976, the new Italian water pollution law obliged the rayon factory to set up a large, new treatment plant for the recovery of Cu and ammonium sulfate; at the same time new plants for domestic and industrial effluents were planned and are now finished or under construction. This resulted in an immediate change in the lake water composition, particularly in the N-NH4 concentration (now at about 2 mg N-NH4/L) and in some signs of recovery in the biological community, e.g. blooms of Brachionus urceolaris and the settlement of a new population of Tubifex tubifex in the profundal zone. A research program is now being conducted on the lake and its 'paralimnion', in order to adequately survey the recovery process and to give useful suggestions for the adoption of possible direct measures. Liming of the South basin of the lake is being seriously taken into consideration and a proper scientific and technical program set up as a collaboration between the CNR-Istituto Italiano di Idrobiologia, Pallanza and the Regione Piemonte and the Provincia di Novara. (See also W89-02137) (Lantz-PTT)
W89-02142

RESTOCKING OF GREAT LAKES FISHES AND REDUCTION OF ENVIRONMENTAL CONTAMINANTS 1960-1980,
Michigan State Univ., East Lansing.
For primary bibliographic entry see Field 8I.
W89-02148

LEGAL AND PUBLIC INFORMATION CHANGE NEEDED,
National Fisheries Inst., Inc., Washington, DC.
L. J. Weddig.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 281-289.

Descriptors: *Water pollution control, *Information exchange, *Legal aspects, *Public policy, Regulations, Public participation, Water pollution prevention, Degradation.

Prevention of degradation and use of our waterways as convenient disposals for chemicals and modern living in general must be a major concern, not only to assure the wholesomeness of fishery products, but also to avoid the negative effects of toxins on the ability of the resources to reproduce and flourish. There is no way of knowing whether the major decline in such stocks as the Atlantic Coast striped bass is due to the fishing pressure, eutrophication, or toxic contamination of waterways were spawning takes place. The matter of preventing further degradation of these waters is a topic for another day. In this paper two aspects of dealing with the problem are commented on: One, the law itself and its interpretation and two, the flow of information to the public. (See also W89-02137) (Lantz-PTT)
W89-02152

MICHIGAN'S PROCESS FOR REGULATING TOXIC SUBSTANCES IN SURFACE WATER PERMITS,
Michigan Dept. of Natural Resources, Lansing. Surface Water Quality Div.
J. E. Grant.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 317-328, 2 ref.

Descriptors: *Water quality control, *Michigan, *Water pollution control, *Permits, *Regulations, Fisheries, Management planning, Water pollution prevention, Guidelines, Toxicity, Chemical wastes.

A necessary aspect of fisheries management is a water pollution control program that wil not only provide nontoxic water quality conditions but also ensure that fish do not contain unacceptable levels of toxic substances for human consumption. Michigan has recently promulgated revisions to Rule 323.1057 of its Water Quality Standards that establish a regulatory process that will protect public health and the environment from discharges of toxic substances from point source surface water discharges. Rule 57(2) specifically addresses the development of allowable toxicant levels in the waters of the state applicable to point source dischargers. The universe of chemicals to which the subrule applies is defines, an upper boundary on estimated excess risk of 1 in 100,000 for non-threshold carcinogens is established, comprehensive procedural guidelines are mandated and a mechanism for issuance of scheduled abatement permits is provided. This paper reviews the development of the rule amendments and discusses key aspects of the adopted rules and guidelines. (See also W89-02137) (Author's abstract)
W89-02154

TOXIC CONTAMINATION IN LARGE LAKES. VOLUME III: SOURCES, FATE, AND CONTROLS OF TOXIC CONTAMINANTS.
Lewis Publishers, Chelsea, Michigan, 1988. 440p.
Edited by Norbert W. Schmidtke.

Descriptors: *Conferences, *Water pollution control, *Fate of pollutants, *Wastewater treatment, *Lakes, *Water pollution sources, Chemical treatment, Biological treatment, Recycling, Bioassay, Water quality control, Toxicity, Municipal wastewater, Industrial wastewater.

The third of four volumes on toxic contamination in large lakes focuses on the sources and fate of contaminants and methods for their control. The papers included were presented at a conference on large lakes held in Michigan in May 1986. The 22 papers in the third volume cover such topics as the contribution of urban and agricultural areas to lake pollution, atmospheric sources of toxic materials, the prediction of exposure potential, integrated waste mangement, contamination of Lakes Ontario, Superior Michigan, Baikal, Maggiore, and Managua. (See W89-02121; W89-02137; W89-02156 thru W89-02176) (Lantz-PTT)
W89-02155

WASTE: THE ENIGMA OF THE 80'S,
Limno-Tech, Inc., Ann Arbor, MI.
For primary bibliographic entry see Field 6A.
W89-02156

SOURCES AND ROUTES OF TOXIC CONTAMINATION FROM MANUFACTURING OPERATIONS,
Shiga Prefectural Dept. of Civil Life and Environment, Otsu (Japan).
For primary bibliographic entry see Field 5B.
W89-02158

WEALTH GENERATOR OR ENVIRONMENTAL PROTECTOR. THE APPROACH OF A CHEMICAL COMPANY TO PROCESS AND PRODUCT DEVELOPMENT UNDER INCREASING ENVIRONMENTAL PRESSURES,
Imperial Chemical Industries Ltd., Brixham (England).
For primary bibliographic entry see Field 6E.
W89-02163

TOXICOLOGY TESTING AS A CONTROL STRATEGY,
Chemical Industry Inst. of Toxicology, Research Triangle Park, NC.
R. A. Neal.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 151-163, 7 ref.

Descriptors: *Toxicology, *Toxicity, *Water pollution control, *Water pollution effects, *Epidemiology, Public health, Water quality control, Chemical analysis, Biological studies.

If the level of exposure is sufficient, chemicals have the capacity to cause a wide variety of toxic effects in humans. There are a number of means available to assess the ability of chemicals to adversely affect humans. The most important of these are epidemiology and tests in experimental animals. Epidemiology provides the most direct or least ambiguous data concerning whether adverse health effects have occurred in humans exposed to a chemical. Unfortunately, there are a number of limitations to the use of epidemiology. These limitations are detailed in the paper. However, the most important limitation is lack of sensitivity. Currently, tests in animals are the most useful means available for determining the potential of a chemical to cause toxic effects in humans. A wide variety of protocols have been developed to determine the potential of chemicals to cause a wide variety of toxic effects in experimental animals, but a major limitation of animal tests is uncertainty about the degree of applicability of chemical toxicity observed in experimental animals to humans. This uncertainty extends not only to differences in the qualitative response of experimental animals and humans to chemicals, but more particularly to uncertainty about differences in the degree of response to various exposure levels. Unquestionably, the best estimate of the potential of a chemical to cause toxicity in humans is derived by use of all the data that are available (epidemiology, results in animals, results in other model systems, knowledge of the mechanism of toxicity of the chemical). (See also W89-02155) (Author's abstract)
W89-02164

RISK ASSESSMENT/RISK MANAGEMENT AS A TOXIC CONTROL STRATEGY,
ICF-Clement, Washington, DC.
For primary bibliographic entry see Field 6A.
W89-02167

PCBS ON THE GLOBE: POSSIBLE TREND OF FUTURE LEVELS IN THE OPEN OCEAN ENVIRONMENT,
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
For primary bibliographic entry see Field 5B.
W89-02170

DEGRADATION OF LAKE BAIKAL: FATE AND EFFECTS OF CONTAMINANTS PRESENT,
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
For primary bibliographic entry see Field 5B.
W89-02171

TOXIC CONTAMINATION IN LARGE LAKES. VOLUME IV: PREVENTION OF TOXIC CONTAMINATION IN LARGE LAKES. MANAGING A LARGE ECOSYSTEM FOR SUSTAINABLE DEVELOPMENT.
Lewis Publishers, Chelsea, Michigan, 1988. 321p.
Edited by Norbert W. Schmidtke.

Descriptors: *Conferences, *Lakes, *Water pollution prevention, *Water quality control, *Environmental protection, Agriculture, Hazardous wastes, Waste disposal, Public participation, Public policy.

The fourth of four volumes on toxic contamination in large lakes focuses on contamination prevention. The papers included were presented at a confer-

ence on large lakes held in Michigan in May 1986. The 26 papers in the fourth volume include studies of Lake Biwa, Japan; Lake Geneva, and the Great Lakes; the role of the news media, citizen groups, and research in determining public policy with respect to lake management; and several studies on the international aspects of pollution prevention and cleanup of large lakes. Three papers are included on large Chinese lakes. The volume also contains summaries of the four conference sessions. (See W89-02121; W89-02137; W89-02155; W89-02177 thru W89-02195) (See also W89-02176) (Lantz-PTT)
W89-02176

ECONOMIC VIEW OF THE GREAT LAKES,
Center for the Great Lakes, Chicago, IL.
For primary bibliographic entry see Field 6A.
W89-02177

TRANSBOUNDARY MANAGEMENT OF LAKE GENEVA,
Republic et Canton de Geneve, Suisse. Dept. des Traveaux Publics.
For primary bibliographic entry see Field 6E.
W89-02180

CLEANING ABANDONED CHEMICAL WASTE SITES AND THE LARGER PROBLEM OF PREVENTING NEW DUMPS,
Pollution Probe Foundation, Toronto (Ontario).
For primary bibliographic entry see Field 5E.
W89-02182

3P PROGRAM: AN EFFECTIVE APPROACH TO INDUSTRIAL POLLUTION,
Minnesota Mining and Mfg. Co., St. Paul.
For primary bibliographic entry see Field 6A.
W89-02183

STRATEGIES FOR CONTROL OF NON-POINT SOURCE POLLUTION,
American Farmland Trust, Washington, DC.
N. A. Berg.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 155-178, 2 fig, 2 tab, 12 ref.

Descriptors: *Water pollution control, *Water pollution sources, *Nonpoint pollution sources, *Regulations, *Management planning, Erosion control, Animal wastes, Phosphorus, Information exchange, Education, Economic aspects.

In 1972, the U.S. Congress, in amending the U.S. Water Pollution Control Act (P.L. 92-500) set a national goal to eliminate all water pollutant discharges by 1983. The nation's waters are not yet pristine and point-source water pollution controls alone are proving insufficient to meet the objectives of the Clean Water Act. The final report of PLUARG, Environmental Management Strategy for the Great Lakes System, to International Joint Commission in 1978, is still valid. It resulted from an extensive six year study of the impact on water quality from and used for a variety of activities, including agricultural, forestry, transportation, urban development and waste disposal. Pollution from nonpoint sources is best characterized by the large numbers, the wide variety, the intermittent nature of inputs, the seemingly insignificant nature of the individual contributions, the damaging effect of the cumulative impact, and a wide variety of economic, social and institutional interactions playing a role. Key elements of the recommended strategy included regional prioritization of problem areas, expansion of soil erosion and animal waste control programs, comprehensive management strategy, and incorporating the load reduction schedules for phosphorus in the Great Lakes Water Quality Agreement between Canada and the U.S.A. After nearly a decade of implementation of the four major components of the 'Strategy' (information, education and technical assistance, planning, fiscal arrangements and regulation, current problems) are analyzed. The recommendations in 1978 by PLUARG provided a solid foundation for accelerating nonpoint source programs. Flexible management systems and control measures capable of incremental adjustments in response to a changing environment will be required. (See also W89-02176) (Author's abstract)
W89-02186

SETTING PRIORITIES FOR GREAT LAKES ENVIRONMENTAL QUALITY RESEARCH,
National Oceanic and Atmospheric Administration, Rockville, MD. Ocean Assessments Div.
For primary bibliographic entry see Field 6A.
W89-02188

ROLE OF THE NEWS MEDIA IN DETERMINING PUBLIC POLICY FOR THE GREAT LAKES,
Globe and Mail, Toronto (Ontario).
For primary bibliographic entry see Field 6A.
W89-02189

ROLE OF RESEARCH IN MANAGEMENT OF THE LAURENTIAN GREAT LAKES,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
For primary bibliographic entry see Field 6A.
W89-02190

INTERNATIONAL AGREEMENTS AND STRATEGIES FOR CONTROLLING TOXIC CONTAMINANTS,
Butler Univ., Indianapolis, IN. Holcomb Research Inst.
For primary bibliographic entry see Field 6E.
W89-02191

ECOSYSTEM MANAGEMENT: OVERCOMING JURISDICTIONAL DIVERSITY THROUGH LAW REFORM,
Canadian Environmental Law Research Foundation, Toronto (Ontario).
For primary bibliographic entry see Field 6E.
W89-02192

PROTECTION OF THE PLATEAU LAKES IN YUNNAN PROVINCE,
Environmental Science Research Inst. of Yunnan Province, Kunming (China).
F. Liu, X. Zhang, and J. Zhang.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 277-286, 2 tab.

Descriptors: *Lakes, *Yunnan Province, *China, *Environmental protection, *Water management, *Water pollution control, Ecological effects, Tourism, Recreation.

Yunnan Province is located in the southwest area of China, bound by Vietnam and Laos on the south and adjoining Burma in the east. Lakes are very important to the Yunnan people for living and development of their economy. The relationship between development and protection, short-term and long-term benefits, individual and comprehensive benefits, economic and social benefits, economic and environmental benefits was not considered during the development of the lake resource. All this resulted in a shortage of water, ecological environmental deterioration, ecological balance dislocation, drought aggravation, calamity increase and obstacles to economic development. To study lake protection from the environmental system optimization point of view, requires most importantly, that water pollution be controlled, water quality be improved and water problems be tackled in a comprehensive way. Methods of pollution control would include: (1) putting the lake under management, limiting new pollution source; (2) controlling existing pollution sources, discharge pollutant concentration and total discharge volume; (3) reclaiming municipal wastewater for comprehensive utilization to decrease the new water demand; and (4) developing strict discharge standards. Ecological initiatives, establishing a protection area and developing tourist trade, and establishing a mechanism for lake management, are other routes for improving the lake protection program. (See also W89-02176) (Lantz-PTT)
W89-02194

AGRICULTURE AND NATURAL RESOURCES: THE BROADENING HORIZON,
Michigan State Univ., East Lansing. Coll. of Agriculture and Natural Resources.
For primary bibliographic entry see Field 6A.
W89-02197

PERSPECTIVE ON SOIL AND WATER CONSERVATION AND AGRICULTURALLY RELATED GROUNDWATER CONTAMINATION,
Soil Conservation Service, East Lansing, MI.
For primary bibliographic entry see Field 4C.
W89-02198

ENVIRONMENTAL IMPACTS OF LARGE SCALE HOG PRODUCTION FACILITIES,
Michigan State Legislature, Lansing. Legislative Science Office.
R. Shaffer, and J. VanderMeulen.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 129-146, 4 fig, 1 tab, 21 ref.

Descriptors: *Hogs, *Farm wastes, *Water pollution prevention, *Water pollution sources, *Odor control, *Regulations, Manure, Fertilizers, Groundwater pollution, Surface water, Bacteria, Nutrients.

In 1982, 73% of the Michigan swine producing farms had inventory of 1 to 99 head of hogs, 19% had 100-499 head and only 7% had > 500 head. One of the most significant concerns with any large scale livestock production facility is the management of animal wastes. These wastes are the primary source of odor from swine production facilities and pose significant risks to groundwater quality. Usually regarded as less offensive when first excreted, manure that is allowed to undergo anaerobic or septic decomposition is considered much more offensive. In addition to odor, animal wastes can contribute pollutants to surface water and groundwater if not properly managed. Depending on its state of decomposition, manure contains significant amounts of chemical nutrients, as well as oxygen-demanding substances and bacterial organisms that degrade water quality. If these wastes are spread on the land surface, rain and snow melt may wash the pollutants into local ponds, lakes, and streams. Where these wastes are concentrated and allowed to seep or wash through the upper soil zones, these chemical substances may also degrade the groundwater (primarily through nitrate contamination). Waste management in hog production, whether in pasture, semiconfined, or roofed confinement facilities, begins with manure management in these facilities. Removing wastes, pretreating wastes, and field applications of waste are the second step, which is then followed by disposal/odor control. The regulatory framework for controlling wastes for water resource protection comprise the remainder of this discussion. (See also W89-02196) (Lantz-PTT)
W89-02204

ABATEMENT OF NITRATE POLLUTION IN GROUNDWATER AND SURFACE RUNOFF FROM CROPLAND USING LEGUME COVER CROPS WITH NO-TILL CORN,
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
M. S. Smith, W. W. Frye, S. J. Corak, and J. J. Vargo.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 161-176, 8 tab, 16 ref.

Descriptors: *Nitrates, *Groundwater pollution, *Water pollution control, *Surface runoff, *Crops, *Legumes, Vetch, Fertilizers, Soil amendments, Lysimeters, Spatial variation, Leaching.

The objectives of this research project were: (1) To compare the leaching of nitrate in soil treated with nitrogen fertilizer and soil with a legume cover crop as the source of nitrogen; (2) To compare fertilized and cover crop soil with regard to soil structure, porosity, and infiltration rates; (3) To measure potential rates of soil water consumption under a living cover crop in the spring, under a killed cover crop in early summer, and in soil without a cover crop; (4) To relate the resulting approximate soil water budgets to the potential for leaching and surface runoff. It has been hypothesized that the growth of legume cover crops would increase soil organic matter content, improve soil structure and so increase water infiltration into soil. To test this hypothesis, an attempt was made to measure steady state ponded infiltration rates. The treatments chosen for comparison either had no winter cover crop or had grown a winter cover crop of hairy vetch for seven years. In both cases, corn was the summer grain crop. These were no-till soils; there was no plowing or disturbance of the soil. These methods were shown to be inadequate. The primary reason is the extreme spatial variability. This makes it impractical to determine treatment differences with any feasible number of samples. This variability suggests that water and nitrate flux from the soil is heterogeneous in space. Another difficulty with these approaches is that they provide single point measurements, in both a temporal and spatial sense. Therefore, they do not directly assess flux of water or nitrate. Enclosed lysimeter systems resolve these difficulties primarily by allowing collection of all flow from a defined area but also by sampling a larger number of soil. Early results suggested that nitrate leaching was greater with vetch amended soil than with fertilizer amended soil. A study of the decomposition and transformations of vetch nitrogen using 15-N labeled plant material was successfully completed. The results indicate that vetch N, in comparison to fertilizer N, leads to lower concentrations of soil inorganic N and greater immobilization of added N in soil organic matter. This would reduce the potential for nitrate leaching. (See also W89-02196) (Lantz-PTT)
W89-02206

USING CROP MODELS AS A DECISION SUPPORT SYSTEM TO REDUCE NITRATE LEACHING,
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
J. T. Ritchie.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 179-192, 4 fig, 1 tab, 21 ref.

Descriptors: *Water pollution control, *Model studies, *Computer models, *Crop models, *Nitrates, Leaching, Weather, Data interpretation, CERES, WGEN, Nitrogen, Nutrients.

Computer models, when coupled with generated or long-term weather and soils data, are valuable tools providing insight into many aspects of decision making for crop production systems. With long-term weather data and a crop model, year-to-year variations in yield can be quantified and thus used in making risk assessment. For the assessments to be correct and credible, however, crop models must be validated in the region where the analysis is needed. Crop models such sa CERES and WGEN (a weather generating model) have limitations for broad applicability. They can only account for variations in the factors included in the models. Potentially important factors not included in the model are assumed to be nonlimiting. The major factors not considered in the models described in this paper include pests and nutrient deficiencies other than nitrogen. Models of these factors can be coupled with crop models, as was done with nitrogen in the CERES models, resulting in even more valuable models. Decision support systems that include crop models can and must play an increasing role in agricultural decision making. For this to happen, interdisciplinary teams will be needed to provide the necessary input information for running and validating models and for building new components into models. There is also a need to make models user-friendly to meet the needs of farmers and policy makers in various regions of the world. (See also W89-02196) (Lantz-PTT)
W89-02207

GROUNDWATER MONITORING: AN OVERVIEW FROM FIELD DRILLING TO LABORATORY ANALYSIS,
Keck Consulting Services, Williamston, MI.
For primary bibliographic entry see Field 5A.
W89-02209

DRINKING WATER STANDARDS: THEIR DERIVATION AND MEANING,
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
C. Vogt, and J. Cotruvo.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 213-223, 7 tab, 2 ref.

Descriptors: *Drinking water, *Water quality control, *Standards, Maximum contaminant level goals, Toxicity, Water quality, Regulations.

National Primary Drinking Water Regulations are being developed by the U.S. EPA for more than 80 contaminants in drinking water (many volatile organic chemicals, microbiology and turbidity, inorganic chemicals, organic chemicals, and radionuclides) under the Safe Drinking Water Act. Nonenforceable health goals, i.e., Maximum Contaminant Level Goals (MCLGs) are to be set at the no adverse effect level; and the enforceable standards, i.e., Maximum Contaminant Levels (MCLs) are to be set as close to the MCLGs as feasible. Feasibility includes the availability/performance/cost of treatment technologies, the availability/capacity of analytical methods and other factors. The fundamental concepts and approaches used by EPA in setting MCLGs and MCLs are presented, and present, future and final MCLGs and MCLs are tabulated. (See also W89-02196) (Lantz-PTT)
W89-02210

RISK CONSIDERATIONS IN PESTICIDE PUBLIC POLICY DECISION MAKING IN WISCONSIN,
Wisconsin Dept. of Justice, Madison. Public Intervenor Office.
For primary bibliographic entry see Field 6A.
W89-02214

COUNTY LEADERSHIP FOR GROUNDWATER CONCERNS,
Western Michigan Univ., Kalamazoo. Science for Citizens Center.
For primary bibliographic entry see Field 6E.
W89-02218

RURAL GROUNDWATER CONTAMINATION: IMPACTS OF AND POTENTIAL BENEFITS FROM LAND USE PLANNING AND ZONING,
Michigan State Univ., East Lansing. Dept. of Agricultural Economics.
L. W. Libby, and J. T. Kovan.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 351-375, 14 ref, 2 append.

Descriptors: *Water pollution control, *Groundwater pollution, *Groundwater quality, *Land use, *Management planning, Aquifers, Public participation, Local governments.

The institutional character of groundwater quality absolutely mandates public action. There are few situations where the polluting action itself creates incentives that are translated back to the polluter and are sufficient to change private behavior. Exceptions are cases where the polluter destroys his or her own water supply, or as in farming where application of 'too much' nitrogen or pesticide results in contamination. Despite high information costs, defensible adjustments in the rights and incentives for users of groundwater quality require considerably more groundwater and related land data. There are Constitutional and other legal limits on arbitrary restrictions to individual rights, and all water users are entitled to equal protection. Despite the meager record of achievement thus far, local policy for groundwater protection shows the greatest promise for immediate protection. The fourteen regional planning commissions have the essential capability of encouraging consistent local action across jurisdictional boundaries. However, local governments are better able to protect recharge areas than control polluters. Regulation against such specific polluting activities as waste disposal must be state and federal. To get serious about the most damaging agricultural practices will take state action as well. A successful program of public education was developed by the East Michigan Environmental Action Council for nine townships in western Oakland County. The program began after discovery of two illegal toxic waste disposal sites in 1979 generated considerable citizen anxiety. The program was based on the belief that 'effective public education for groundwater protection must be carried out by local citizens.' A three-part classification system was established enabling planners to pinpoint groundwater pollution problems areas. By overlaying maps of aquifer vulnerability with groundwater use, a composite map was developed which systematically determined relative priorities for a proposed groundwater management plan. (See also W89-02196) (Lantz-PTT)
W89-02219

INDUSTRY/AGENCY PERSPECTIVES ON STRATEGIES FOR PROTECTING GROUNDWATER,
National Agricultural Chemicals Association, Washington, DC.
For primary bibliographic entry see Field 6E.
W89-02220

FEDERAL AND STATE ASSISTANCE FOR ACTION,
Geological Survey, Lansing, MI.
For primary bibliographic entry see Field 6E.
W89-02221

INTERNATIONAL CONFERENCE ON INNOVATIVE BIOLOGICAL TREATMENT OF TOXIC WASTEWATERS.
For primary bibliographic entry see Field 5D.
W89-02267

PHYSICAL-CHEMICAL AND ANAEROBIC FIXED FILM TREATMENT OF LANDFILL LEACHATE,
Technical Univ. of Nova Scotia, Halifax. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-02276

TREATMENT OF LEACHATE FROM A HAZARDOUS WASTE LANDFILL SITE USING A TWO-STAGE ANAEROBIC FILTER,
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5D.
W89-02277

EFFECTS OF EXTENDED IDLE PERIODS ON HAZARDOUS WASTE BIOTREATMENT,
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-02278

BIOTECHNOLOGY FOR THE TREATMENT OF HAZARDOUS WASTE CONTAMINATED SOILS AND RESIDUES,
Cook Coll., New Brunswick, NJ. Dept. of Biological and Agricultural Engineering.
M. E. Singley, A. J. Higgins, V. S. Rajput, S. Pilapitiya, and R. Mukherjee.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 362-378, 4 fig, 1 tab, 22 ref.

Descriptors: *Fate of pollutants, *Cleanup operations, *Toxic wastes, *Biological treatment, *Hazardous wastes, *Soil contamination, Biodegradation, Physical treatment, Chemical treatment, Sludge, Thermograms, Microcalorimeter, Microbiological studies, Toxicity.

The research reported in this paper deals with the development and use of biotechnology for treating contaminated soils and waste residues at the site of the problem. The major treatment methods include physical/chemical washing of soils and waste residues as a pretreatment followed by biological degradation. tHe pretreatment followed by biological degradation. The challenge to pursue the use of biological degradation arose from previous work by two of the authors concerning the composting of sewage sludge which frequently contains hazardous organic compounds. In the biodegradation of hazardous wastes, it is quite probable that some compounds may exhibit greater toxicity to microbes than others. In the biodegradation of hazardous wastes, it is quite probable that some compounds may exhibit greater toxicity to microbes than others. In addition, the concentration in the media may also play an important role in determining the level of tolerance. The microcalorimeter used in this study is a device that offers a convenient and relatively quick way of determining the interaction of the microbiological community with a contaminant. Each contaminant or combination of contaminants must be checked to learn first if the contaminant is metabolizable and , second, what the maximum level of concentration of the contaminant can be. The microbial activity in terms of heat output for a one gram sample is termed a 'thermogram'. A thermogram is recorded over a 1-1/2 to 2 day period, and provides the information that shows the feasibility of using the microbiological community to degrade an organic contaminant. The effect of frequent successive applications at acceptable loading rates compared with single dose may also be important in sustaining the microbial population. The use of pretreatment mechanisms such as extraction and chemical conversion may help reduce the levels of these compounds to concentrations amenable to biodegradation. (See also W89-02267) (Lantz-PTT)
W89-02285

BIOLOGICAL DEGRADATION OF POLYCHLORINATED BIPHENYLS,
General Electric Corporate Research and Development, Schenectady, NY. Biological Sciences Branch.
R. Unterman, M. J. Brennan, R. E. Brooks, and C. Johnson.
IN: International Conference on Innovative Biological Treatment of Toxic Wastewaters. June 24-26, 1986, Arlington, Virginia. April 1987. p 379-389, 3 fig, 5 ref.

Descriptors: *Fate of pollutants, *Cleanup operations, *Soil contamination, *Toxic wastes, *Biodegradation, *Polychlorinated biphenyls, *Biological treatment, Bacteria, Microbiological studies, Soil bacteria.

The polychlorinated biphenyls (PCBs) are a family of compounds that were commonly used over the last half century. Their release and accumulation in the environment and possible effects on human health have sparked an intense interest in devising technologies for their destruction or safe disposal. For these reasons a research program was studied several years ago to further investigate the bacterial degradation of PCBs. Initially, over two dozen new bacterial strains were isolated capable of growth on biphenyl (BP) as sole carbon source. These strains exhibited exceptional and novel PCB-degradative competence. This research has demonstrated the biodegradation of various soil-bound PCBs under a variety of conditions, using both pure and mixed cultures of the bacterial strains MB1, H850, and LB400. The authors conclude from these results that it should be possible to biologically degrade PCBs on contaminated soil in the environment with appropriate cell concentration and moisture conditions. (See also W89-02267) (Lantz-PTT)
W89-02286

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

SIMULATION MODEL FOR HYDROLOGIC MANAGEMENT (MODELE DE SIMULATION DE LA GESTION HYDROLOGIQUE),
Laval Univ., Quebec. Dept. of Civil Engineering.
L. Llamas, R. Fernandez, and A. Galvache.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 2, p 206-215, April 1988. 12 fig, 2 tab, 19 ref. English summary.

Descriptors: *Planning, *Water management, *Resources management, *Hydroelectric power, *Flood control, *Recreation, Mathematical models, Simulation analysis, St. Francois River Basin, Canada.

A general methodology for simulation of water resources management is suggested. Research was conducted in three different levels: an analysis of the historical management procedures, the development of some alternative ways to optimal management, and the establishment of planning criteria at short, middle, and long term. The main constraints, divided into three categories according to the severity of probable losses, have been defined as a function of several expected goals: hydro power, flood control, recreational activities, etc. The model was applied with excellent results to the upper region of the St. Francois River Basin (Quebec, Canada). (Author's abstract)
W89-01337

REPRESENTING HYDROPOWER IN HYDROTHERMAL POWER SYSTEM,
Tennessee Valley Authority, Norris. Engineering Lab.
For primary bibliographic entry see Field 6D.
W89-01366

ASSESSING THE RISK OF VIOLATING STREAM WATER QUALITY STANDARDS,
Wyoming Univ., Laramie. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-01373

MOUNTAIN CATCHMENT MANAGEMENT WITH GOAL PROGRAMMING,
Department of Environmental Affairs, Pretoria (South Africa).
For primary bibliographic entry see Field 4A.
W89-01374

SYSTEMS ANALYSIS,
North Carolina Agricultural and Technical State Univ., Greensboro. Dept. of Civil Engineering.
S. -Y. Chang.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 743-746, June 1988. 53 ref.

Descriptors: *Literature review, *Systems analysis, *Water pollution control, *Model studies, Mathematical models, Nonpoint pollution sources, Storm water, Management planning, Water treatment, Wastewater treatment, Rivers, Estuaries.

Literature published in 1987 on systems analysis applied to water pollution control is summarized under the following headings: river basin and estuary models, nonpoint source pollution and stormwater management, lake models, groundwater models, and optimization models of water and wastewater treatment. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01461

LEADING QUESTION: IN SITU STRUCTURES OF THOUGHT,
G. W. Stewart.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 137-157.

Descriptors: *Management planning, *Environmental protection, *Economic aspects, Decision-making, Canada, Government supports.

Habitual failure to take continuing account of the global environmental context in economic and social decision-making processes, generates and sustains a fundamental error of logic in the depiction of the situation and its possibilities. With effort, this error is correctable. Its deliberate and conscious correction would have vast practical consequence for human decision-making and open extraordinary opportunities to persons and societies. To illustrate how this thesis has been approached in an organizational setting, a description is included of a project in which the author as a member of a community was asked to assist an environmental department of government and its Minister to address the environment-economy relationship. In the course of the project, the illogic of the department's present construction of the environment/economy relationship was identified and it was possible to develop policy options whereby the agency could strengthen its role within government by correcting its own approach, and play a major national and international role in helping to remedy our habitual failing to take the environmental context logically into account. Environment Canada thinks about environment in terms of elements that enter into the human economy. It would do better to think of human economies as elements that enter into the environment, and start from there. A new situation vis-a-vis the natural environment with the recent growth in human numbers and activities has been entered. It is time to give the matter serious attention and to begin to adjust actions appropriately and explore new opportunities. Environment Canada could best fulfill its mandate to protect and enhance the environment by being helpful in this process. (See also W89-01714) (Lantz-PTT)
W89-01729

COMPUTER MODELS IN ENVIRONMENTAL PLANNING,
Ohio State Univ., Columbus. Dept. of City and Regional Planning.
S. I. Gordon.
Van Nostrand Reinhold Co., New York. 1985. 222p.

Descriptors: *Management planning, *Computer models, *Environmental policy, *Water pollution control, *Planning, *Model studies, Environmental effects, Water quality, Stormwater runoff, Land use, Hazardous wastes, Computer programs, Waste disposal.

The use of computer models in environmental planning and environmental impact analysis is constantly growing. This guide shows how to work a wide range of models for water quality, air quality, stormwater runoff, land capability/land information systems, and hazardous waste disposal. The author reviews, compares, and critiques major models in each of these areas and explains how to use various computer programs. The book provides information on: computer codes used in environmental planning; model input requirements and sample outputs; where and how to obtain models; water quality models (traditional, Streeter-Phelps, and innovative statistical approaches); differences among air quality computer codes; and attributes of stormwater models. A special section reviews the state of the art of hazardous waste models - a relatively new area in environmental planning. This discussion covers models used for locating and disposing toxic chemical wastes, rating systems for hazardous waste facility location, and models for groundwater flow and aquifer contamination analysis. (Lantz-PTT)
W89-01823

ECOLOGICAL ANALYSIS OF WASTEWATER MANAGEMENT CRITERIA IN WETLAND ECOSYSTEMS,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 5D.
W89-01851

STATE (LARGE-SCALE) HYDROELECTRIC RESOURCES,
Ministry of Works and Development, Wellington (New Zealand).
G. G. Natusch.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 4-17, 3 tab, ref.

Descriptors: *Water resources development, *Hydroelectric plants, *New Zealand, *Environmental impact, *Management planning, Economic aspects, Electricity, Social aspects, Economic aspects, Costs, Hydroelectric power.

A hydroelectric power-station must contain facilities for passing water from a high to a low level with a minimum loss of head. There are several ways in which that can be done. Where there is a natural waterfall or rapids, a tunnel or canal can bypass the course of the river with a minimum loss of head. In other circumstances a dam can be built, or water diverted from one catchment to another. Investigation of hydroelectric potential is an ongoing process. Options are brought up to date and discussed in the Annual Energy Plan and reports (published up by the Government Printer) of the Electricity Sector Planning Committee which superseded the Power Planning Committee. The acceptability of any electrical proposal must depend on the balance between its financial and the less quantifiable social and environmental effects. Hydroelectric possibilities that are feasible but ignore most of the environmental, and social matters that their development might raise, are: Upper Clutha, Kawara, Lower Clutha, Lower Waitaki, Motu, and Mohaka. Financially hydroelectric proposals have to be ranked with each other and with other methods of producing electrical or other useful energy. At present these other forms are mainly coal, natural gas, and oil-fired thermo-electric stations, with geothermal generating stations as a minor support. Hydroelectric stations have the advantages that their motive force is virtually costless and inexhaustible so that, once built, station expenses are relatively stable. At present the movement of relative costs of construction and fuels is difficult to forecast. On the basis of the 1984 Energy Plan it can be expected that hydroelectricity will find favor well into the next century, to be developed in parallel with thermal power-stations. Beyond that its acceptability will depend on the balance from year to year between construction costs, cost of indigenous and imported fuels, and the weight attached to environmental and social factors. (See also W89-01871) (Lantz-PTT)
W89-01872

LOCAL (SMALL-SCALE) HYDROELECTRIC RESOURCES,
Ministry of Works and Development, Wellington (New Zealand).
R. E. Stewart.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 18-27, 1 fig, 2 tab, 2 plates, 4 ref.

Descriptors: *Hydroelectric power, *Water resources development, *Environmental impact, *Management planning, *New Zealand, Diversion structures, Intakes, Flood gates, Turbines, Generators, Pipes, Water transfer.

Local hydroelectric development, and how it fits into the overall picture of hydroelectric development in New Zealand, is described. The background and definition of local hydro-schemes, their evolution and current position are detailed together with indications of where such development is headed. The essential physical elements of a local hydro-scheme are common to all hydro-schemes. A flow of water must be diverted through a turbine. The turbine drives a generator whose output is then carried to the user or users. To this end the following identifiable components of a scheme are needed: a water diversion structure; an intake structure; an overflow structure (for surplus or flood flows); a penstock or pressure pipe system; a turbine; a generator; a transmission system. In addition the following components are also commonly used: a water storage structure (normally a dam); a water transfer structure such as a canal or tunnel; and a surge chamber to reduce water hammer pressures on penstocks when the turbines are shut down. Every year the Electricity Sector Planning Committee (Ministry of Energy) publishes a report which gives details of current local hydro-schemes and estimates of their generation for the following 15 years. Because this is based on government policy at the time and a local hydro-scheme could be built within five years from inception, these estimates are increasingly inaccurate towards the end of the 15-year period. This aspect affects all attempts to predict the future development of local hydro-schemes, but it is likely that for the next 15 to 20 years, provided financial and legal obstacles do not increase over those of the early 1980s, there could be some two to four stations being constructed at any one time with a further three to six being investigated, but this will depend on the circumstances of the time. (See also W89-01871) (Lantz-PTT)
W89-01873

TOWN AND COUNTRY PLANNING,
Ministry of Works and Development, Dunedin (New Zealand).
J. A. Paul.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 40-48, 2 fig, 5 ref.

Descriptors: *Water resources development, *Management planning, *Hydroelectric power, *Legislation, *New Zealand, *Resources management, Environmental effects, Resources development, Community development, Funding, Construction.

Investigations and planning for hydroelectric developments normally have a long time-span and go through a series of phases. These phases can be summarized as follows: preliminary investigations and resource studies; definition of development options; evaluation of developing options and choice of preferred option; environmental impact reporting; obtaining statutory consents; Government funding approval; and construction. The statutory consents usually required for hydroelectric proposals are water rights - obtained under the Water and Soil Conservation Act 1967 - and planning consent (obtained under the Town and Country Planning Act 1977). The main purpose of this chapter is to explain the procedures laid down in the Town and Country Planning Act 1977 to obtain planning consent. An explanation of the wider processes of regional planning provided for in the Act and how they correspond with the phases outlined above is also discussed. The interrelationships between the Town and Country Act 1977 and the Water and Soil Conservation Act 1967 and moves towards closer working relationships between water and land planning are also considered. Finally, public involvement under the Town and Country Planning Act is discussed. (See also W89-01871) (Lantz-PTT)
W89-01875

WASTE REDUCTION IN ILLINOIS: AN OVERVIEW,
Illinois State Water Survey Div., Savoy. Hazardous Waste Research and Information Center.
For primary bibliographic entry see Field 5G.
W89-02037

STUDY AND IMPLEMENTATION OF WASTE MINIMIZATION AT IBM AUSTIN,
Montgomery (James M.), Inc., Pasadena, CA.
For primary bibliographic entry see Field 5E.
W89-02038

WASTE: THE ENIGMA OF THE 80'S,
Limno-Tech, Inc., Ann Arbor, MI.
P. W. Rodgers, D. R. Klemans, and P. L. Freedman.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 7-23, 9 fig, 1 tab, 18 ref.

Descriptors: *Water pollution control, *Regulations, *International cooperation, *Waste management, Management planning, Hazardous wastes, Legal aspects, Economic aspects.

The many sources of hazardous wastes combined with their observed mobility suggest that waste management is an international responsibility. Just as science must depend on multi-national efforts for advancement, so too must the regulatory efforts to protect human health and environmental quality. The 'Ecosystem View' discussed here makes it evident that environmental quality is dependent on worldwide toxic sources and controls. This overview of waste problems in the 1980s, makes it clear that data representing international environmental efforts are extremely difficult to obtain. Answers to straight forward questions, such as:...'how much doe the world spend on pollution control'...were not to be found in the literature or from direct contact with international organizations. Even definitions of important terms, such as hazardous waste, are not consistent nor have efforts to develop common terminology, objectives, management approaches, or mechanisms for information exchange been prominently apparent. These observations reflect the more important reality that international or multi-national efforts to examine and regulate toxic chemicals and wastes have not been given the social and litigative attention appropriate to the need. (See also W89-02155) (Lantz-PTT)
W89-02156

WEALTH GENERATOR OR ENVIRONMENTAL PROTECTOR. THE APPROACH OF A CHEMICAL COMPANY TO PROCESS AND PRODUCT DEVELOPMENT UNDER INCREASING ENVIRONMENTAL PRESSURES,
Imperial Chemical Industries Ltd., Brixham (England).
For primary bibliographic entry see Field 6E.
W89-02163

RISK ASSESSMENT/RISK MANAGEMENT AS A TOXIC CONTROL STRATEGY,
ICF-Clement, Washington, DC.
E. L. Anderson, and C. J. Henry.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 191-212, 9 tab, 26 ref.

Descriptors: *Toxic wastes, *Risk assessment, *Waste management, *Water pollution control, Management planning, Chemical wastes, Toxicity, Public health, Environmental protection.

The inevitable presence of toxic chemicals in the environment and the challenges of limiting the consequent risk to health and ecological systems in the face of important social and economic tradeoffs has led to the use of a systematic two-step approach in the United States for controlling toxic chemical exposures. In the first step, a risk assessment is completed; in the second, a risk management decision is reached. Ideally, the risk assessment is performed independent of the management decision to ensure the integrity of the scientific evaluation. Risk assessment is a process for organizing scientific uncertainty to address the following points: (1) the likelihood of a risk occurring; and (2) if its does, the magnitude of the impact in quantitative terms. For toxic chemicals, all relevant scientific data having a bearing on these points are assembled and evaluated to express the weight-of-evidence that a chemical may cause a particular health effect and the magnitude of the risk given current and anticipated exposures. This information is considered together with the social and economic cost of limiting exposure to reach a risk management decision as to what, if any, risk is

acceptable. Risk assessment/risk management has become a powerful tool for the management of toxic chemicals in the United States. While the greatest experience has been with exposures to suspected carcinogens, other effects are being evaluated by a similar approach. This concept could be equally applicable for toxic control strategies in other countries (or) on an international basis, so long as proper recognition is given to the differences in national and international factors, such as competing risk, legal constraints, and economic realities which together with risk assessment form the basis for the ultimate risk management decision. (See also W89-02155) (Author's abstract)
W89-02167

ECONOMIC VIEW OF THE GREAT LAKES,
Center for the Great Lakes, Chicago, IL.
D. W. Wise.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 19-29, 13 ref.

Descriptors: *Great Lakes, *Economic aspects, *Management planning, *Water management, Social aspects, Water resources development, Public policy, Public investment, Water use, Taxes.

The term management is used here in its broadest sense: the political, social and economic measures taken at both the public and private sector levels toward a common regional goal. Four such principles are presented. All are fundamental and perhaps self evident, yet long overlooked. Each rests on the fundamental premise that the economic and environmental considerations in the use and management of the Great Lakes are inseparable: (1) Public institutions and private businesses must reject parochial tendencies to either isolate or merely balance environmental and economic considerations in resource management efforts. Integration is the key: looking at water quality and recognizing its economic implications for waterfront development, or looking at the revitalization of water-based industry and recognizing its contribution to the tax base and subsequently water management programs; (2) It must be recognized that stewardship responsibilities are not exclusively public sector responsibilities; (3) In that same vein, the linkages between these sectors and among existing public institutions must be explored and strengthened; and (4) Finally, the message must be taken to the region's citizens. The Great Lakes are more than merely a tourist attraction or source of drinking water. They are not only a natural asset, but a necessity and a determinant of environmental quality, economic well-being, and quality of life. (See also W89-02176) (Lantz-PTT)
W89-02177

MODEL-BASED EDUCATION SUPPORT SYSTEMS: APPLICATION TO LARGE LAKES AND HAZARDOUS WASTE MANAGEMENT,
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
K. Fedra.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 77-103, 7 fig, 32 ref.

Descriptors: *Model studies, *Management planning, *Waste management, *Lakes, Computer models, Mathematical models, Simulation analysis, Databases.

Large lakes are recipient environmental systems for the waste streams from numerous interdependent human activities. Integrating large and complex physical and at the same time socio-economic catchment areas, their environmental problems are an intricate mixture of physical, biological, technological, economic, and ultimately political causes and their relationships. The aims, scope, and design philosophy of a new generation of model-based decision support systems for large socio-technical and environmental systems are described. These interactive, hybrid systems combine data base management, system simulation, operations research techniques such as optimization, interactive data analysis, elements of decision technology and artificial intelligence, with a menu-driven symbolic and display-oriented user interface. The approach combines quantitative numerical methods with qualitative heuristic descriptions and is designed to give the user direct and interactive control over the system's function. Human knowledge, experience and judgement are integrated with formal approaches into a tightly coupled man-machine system through an intelligent and self-explanatory user interface. Designed on dedicated microcomputer workstations, prototype implementations dealing with problems of lakes and hazardous substances are briefly described. (See also W89-02176) (Lantz-PTT)
W89-02181

3P PROGRAM: AN EFFECTIVE APPROACH TO INDUSTRIAL POLLUTION,
Minnesota Mining and Mfg. Co., St. Paul.
J. T. Ling.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 111-118.

Descriptors: *Industrial wastes, *Water pollution prevention, *Waste management, *Management planning, Minnesota Mining and Manufacturing, Costs, Economic aspects, Environmental protection.

The best way to control toxic substances from industry is at the source. Since industrial pollution is a visible sign of inefficient use of resources, 3M developed a program to fight pollution by not creating it. Industry's traditional approach has been the use of add-on control equipment that changes the form of pollution but does not eliminate it. The 3M Pollution Prevention Pays (3P) program eliminates or reduces pollutants, conserves resources, and encourages innovative technology through product reformulation, process changes, equipment redesign, and recycling or reuse of process waste. Started in 1975, the 3P program, involving 3M operations in the United States and 22 other countries and annually prevents more than 40,000 tons of pollutants and 1.6 billion gallons of wastewater. 3P savings to date total $300 million. 3M's prevention approach has had national and international impact. The program has received awards from the U.S. EPA and other organizations. Some states have adopted pollution prevention as environmental policy. Several world organizations, including the United Nations Environmental Programme and the Organization for Economic Cooperation and Development, have endorsed and promoted the concept. Pollution prevention has become government policy in several countries, including France and Britain. A number of major industrial companies also started prevention programs. Industry, however, is only one source of pollution. Other sources also must be effectively addressed. Since many environmental concerns are international in scope, meaningful government incentives and expanded international cooperation are vital to the development and implementation of innovative solutions to environmental problems, including those of the large lakes. (See also W89-02176) (Author's abstract)
W89-02183

SETTING PRIORITIES FOR GREAT LAKES ENVIRONMENTAL QUALITY RESEARCH,
National Oceanic and Atmospheric Administration, Rockville, MD. Ocean Assessments Div.
A. Robertson.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 189-199, 2 tab, 6 ref.

Descriptors: *Research priorities, *Great Lakes, *Environmental protection, *Policy making, Water quality control, Institutions, Environmental Protection Agency, National Oceanic and Atmospheric Adminstration, Fish and Wildlife Service, Army Corps of Engineers, Model studies.

The U.S. environmental quality research programs on the Great Lakes that support the Great Lakes Water Quality Agreement is outlined, the mechanisms used in setting priorities for these programs are discussed, and the lack of influence of the International Joint Commission (IJC) on the priorities setting process is considered. Funding for such programs is provided largely from four federal agencies - the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, the Fish and Wildlife Service, and the U.S. Army Corps of Engineers. A four-tiered conceptual model is used to portray the federal priority setting process. Although the Great Lakes Water Quality Agreement assigns responsibility to the IJC's Science Advisory Board (SAB) to provide advice on the research needed in support of the Agreement, there is no good mechanism at present for such recommendations to influence this process. It is suggested that the influence of the SAB on the priorities setting process could be improved if the directors of Great Lakes research programs and others who are involved in the priorities setting process were more actively involved in the developing of the SABs recommendations concerning research priorities. (See also W89-02176) (Author's abstract)
W89-02188

ROLE OF THE NEWS MEDIA IN DETERMINING PUBLIC POLICY FOR THE GREAT LAKES,
Globe and Mail, Toronto (Ontario).
M. Keating.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 201-209.

Descriptors: *Public policy, *Public relations, *Great Lakes, Environmental protection, Water pollution prevention, Public participation.

The news media have played a catalytic role in shaping public policy on Great Lakes pollution issues, from the days of the eutrophication debates of the 1960s to the toxics problems of recent years. By publishing information about the deteriorating state of the lakes, the media created pressures for action on the part of the government, industry and non-governmental organizations, the three main actors in the Great Lakes environmental debates. To some degree the media are simply the method by which the main actors in communicate with the public. But the media can also affect the content and impact of the message by giving more attention to some pieces of information and less to others. Once issues have been raised the media can spur debate by focusing continuing attention on them and demanding that officials respond to their questions. In fact governments have often found themselves in the awkward position of having raised public concerns about such problems of drinking water but then are unable to explain what they are going to do about those problems. There are now signs that some governments are re-thinking their strategies and may release less information which raises questions that they cannot answer. Headlines such as: 'PCB Poisons Build up in the Body', 'City Could Become PCB Dump, Mayor Asserts', 'Toxic Wastes: Tip of the Iceberg', 'Town Fights for Plan for Toxic Waste Treatment Plant', 'Industries Cited for Dumping Hazardous Wastes', and 'Lack of Planning for Disposal Crisis May Lead to Shut-Downs in Industry', have been seen recently in publications such as the New York Times and New Scientist magazine of Great Britain. They indicate that the public are concerned about the state of the environment, and do not feel that those in charge are, in general, coping adequately with the situation. This paper, deals with the role of the media in the shaping of public policy in the context of toxins in the Great Lakes. (See also W89-02176) (Lantz-PTT)
W89-02189

ROLE OF RESEARCH IN MANAGEMENT OF THE LAURENTIAN GREAT LAKES,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
A. M. Beeton.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 211-219, 14 ref.

Descriptors: *Great Lakes, *Management planning, *Research priorities, *Water pollution control, Water management, Crisis management, Toxicity, Economic aspects, Cost-benefit analysis, Interagency cooperation.

There are two sound reasons for emphasizing the role of research in management of the Laurentian Great Lakes. First, the scientist in the universities, state and federal agencies recognize that the problems which are faced today, especially toxic contaminants, cannot be dealt with by crisis management. The critical processes of Great Lakes ecosystems need to be understood in order to manage uses of these lakes in such a way as to minimize adverse impacts. Second, research in the Great lakes can provide valuable knowledge and insights for research on small lakes and the oceans. Most management and research organizations agree to an ecosystem approach for the Great Lakes. This approach means that all the agencies must interact and cooperate in their research. An integrated 'use management plan', developed on the basis of knowledge on how the Great Lakes ecosystems function, should provide for protection and rehabilitation of the quality of the Great Lakes. In terms of toxic substances, such a management plan must deal with: how stresses are best measured, and the cost/benefit relationships when all compartments of the ecosystem are taken into account. The ecosystem approach is not possible because the coordinated basic research needed to understand how the ecosystem functions has not been carried out. Most of the funds for research have been in support of crisis management. If there is to be an ecosystem approach then the management agencies must recognize the need to cooperate in setting an agenda for the research which will provide them with the appropriate knowledge. (See also W89-02176) (Lantz-PTT)
W89-02190

PROTECTION OF THE PLATEAU LAKES IN YUNNAN PROVINCE,
Environmental Science Research Inst. of Yunnan Province, Kunming (China).
For primary bibliographic entry see Field 5G.
W89-02194

AGRICULTURE AND NATURAL RESOURCES: THE BROADENING HORIZON,
Michigan State Univ., East Lansing. Coll. of Agriculture and Natural Resources.
J. H. Anderson.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 3-13, 19 ref.

Descriptors: *Nonpoint pollution sources, *Agricultural chemicals, *Water pollution control, *Management planning, Interagency cooperation, Nonpoint pollution sources, Agriculture, Economic aspects.

Agriculture's present system of voluntary effort to deal with nonpoint pollution problems is being seriously questioned by the public, regulatory agencies and legislators. The cooperation of government agencies, state agricultural experiment station researchers, Cooperative Extension Service personnel and farmers is needed to design relevant research and demonstration projects and to implement strategies for change. Agribusiness and industry must also become involved. A coordinated effort is needed to define cost effective management alternatives, new technology, educational programs and agricultural policies that can be more flexibly applied. This will require many changes in priorities at a time when the main concern for many farmers is simply surviving. The burden cannot simply be placed on the back of the farmer alone. Chemicals have played an important role in the growth of agricultural productivity during the last three decades, but they must be applied more efficiently in order to retain profitability in agriculture and protect the environment at the same time. The judicious and economical use of agrichemicals can still play an important role; but more holistic approaches to agricultural management, coupling efficient crop production and soil conservation with surface and groundwater protection, must be developed. Therefore, it is imperative to broaden the scope of research and the dissemination of knowledge with greater sensitivity to community concerns regarding the protection of the environment. (See also W89-02196) (Lantz-PTT)
W89-02197

USING CROP MODELS AS A DECISION SUPPORT SYSTEM TO REDUCE NITRATE LEACHING,
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
For primary bibliographic entry see Field 5G.
W89-02207

RISK CONSIDERATIONS IN PESTICIDE PUBLIC POLICY DECISION MAKING IN WISCONSIN,
Wisconsin Dept. of Justice, Madison. Public Intervenor Office.
T. J. Dawson.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 261-289, 26 ref.

Descriptors: *Decision making, *Wisconsin, *Public policy, *Pesticides, Risk analysis, Regulations, Economic aspects, Water pollution sources, Enforcement.

Over the last several years, the Office of the Wisconsin Public Intervenor has been involved in pesticide use and control policy making with state and local agencies. As a result, the Public Intervenor Office has received a growing number of requests for information, advice and aid from citizens' groups and local units of government regarding pesticide-related issues. Every year, policy makers at all levels of government are called upon to make important decision regarding pest management and pesticide use within their respective jurisdictions. Being debated in Wisconsin local and state government forums are many of the same issues that are being debated and addressed at other local, state and national levels of government. These issues include: (1) pesticide safety; (2) risk management; (3) risk assessment; (3) EPA pesticide regulations; (5) synergy between pesticides; (6) EPA credibility; (7) pesticide regulatory enforcement; and (8) economic considerations of pesticide use. (See also W89-02196) (Lantz-PTT)
W89-02214

RURAL GROUNDWATER CONTAMINATION: IMPACTS OF AND POTENTIAL BENEFITS FROM LAND USE PLANNING AND ZONING,
Michigan State Univ., East Lansing. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5G.
W89-02219

CURRENT TRENDS IN WATER-SUPPLY PLANNING: ISSUES, CONCEPTS, AND RISKS,
For primary bibliographic entry see Field 5F.
W89-02257

PRIMER FOR COMPUTERIZED WASTEWATER APPLICATIONS.
Water Pollution Control Federation, Alexandria, VA. Task Force on Computerized Treatment Plant Application.
For primary bibliographic entry see Field 5D.
W89-02258

6B. Evaluation Process

LONDON WATER RING MAIN: AN OPTIMAL WATER SUPPLY SYSTEM,
For primary bibliographic entry see Field 5F.
W89-01350

VALUE OF COASTAL WETLANDS FOR RECREATION: AN APPLICATION OF TRAVEL COST AND CONTINGENT VALUATION METHODOLOGIES,
Louisiana State Univ., Baton Rouge. Dept. of Economics.
S. Farber.
Journal of Environmental Management JEVMAW, Vol. 26, No. 4, p 299-312, June 1988. 6 tab, 15 ref, append.

Descriptors: *Wetlands, *Land appraisals, *Recreation demand, *Economic evaluation, *Value, *Surveys, Economic justification, Boating, Fishing, Travel cost, Benefits, Louisiana, Mineral rights, Recreation, Comparison studies.

This study reports on a survey of Louisiana coastal wetlands recreational users, administered for the purpose of estimating wetlands' recreational value. The sampling procedure consisted of placing self-addressed, stamped questionnaires on windshields of all vehicles parked in the morning at all twenty-seven boat launch facilities in Terrebonne Parish (Louisiana) on various dates throughout the period July 1984 to June 1985. The primary technique was the travel cost method. The value estimates obtained using this method were of similar magnitude to those obtained using a contingent valuation question in the survey. Although it may not reflect the marginal recreational value of an acre of wetlands, the average value can be calculated using the wetlands acreage and the estimated consumer surplus. Depending on the time cost value used, the average capitalized value ranged from $36 to $111 per acre. In contrast, an acre of unimproved wetlands sells for approximately $200 per acre, and this is primarily for mineral rights. (Author's abstract)
W89-01372

MOUNTAIN CATCHMENT MANAGEMENT WITH GOAL PROGRAMMING,
Department of Environmental Affairs, Pretoria (South Africa).
For primary bibliographic entry see Field 4A.
W89-01374

ECONOMICS,
East Texas State Univ., Commerce.
M. J. Ellerbrock.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 746-748, June 1988. 33 ref.

Descriptors: *Literature review, *Economics, *Water pollution control, *Cost analysis, Water resources development, Mathematical models, Nonpoint pollution sources, Market value, Value, Policy making, Public policy.

Literature published in 1987 on the economics of water pollution control is summarized under the following headings: nonpoint source pollution, markets, valuation, applied studies, and policy. Cost effectiveness, mathematical models, and water resources development costs are considered. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01462

ASSESSMENT OF SOCIO-ECONOMIC RAMIFICATIONS,
Waterloo Univ. (Ontario). Faculty of Environmental Studies.

G. R. Francis.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 125-129, 16 ref.

Descriptors: *Social impact, *Economic aspects, *Sediment contamination, *Decision making, Social aspects, Waste management, Great Lakes, Management planning.

Implementation of remedial measures for contaminated sediments may well have to contend with the 'not in my backyard' (NIMBY) syndrome. These are situations characterized by high levels of distrust which include transference of these feelings to the assessment techniques used to select the measurers. The experiences of agencies searching for satisfactory solutions to such problems need to be more widely known. Remedial measures for contaminated sediments are but one portion of a set needed to rehabilitate degraded aquatic ecosystems. Recent collaborative work to outline feasible strategies for ecosystem rehabilitation in the Great Lakes is outlined, by identifying the stresses operating in particular situations, the measures for alleviating or removing them can be examined. Such strategies are scientifically feasible, socio-economically defensible, and the institutions to address the problems are available. However, strategies need to be tailored to the circumstances of selected near-shore areas. For two such areas, analyses of societal arrangements have been directed to identifying the relevant 'actor system' composed of government agencies and nongovernmental groups, and assessing the alternatives to regulatory management. Various collaborative processes to facilitate rehabilitative management are noted. (See also W89-01714) (Lantz-PTT)
W89-01727

PERCEPTIONS, PARADIGMS AND ETHICS: A PERSPECTIVE ON THE SOCIAL CONTEXT OF ENVIRONMENTAL ISSUES,
Department of the Environment, Ottawa (Ontario).
For primary bibliographic entry see Field 6G.
W89-01728

FEASIBILITY OF PACKED-BED ANAEROBIC TREATMENT OF POULTRY PROCESSING WASTEWATER,
Georgia Technical Research Institute, Environmental, Health and Safety
For primary bibliographic entry see Field 5D.
W89-02070

FISHERIES MANAGEMENT, WATER QUALITY AND ECONOMIC IMPACTS: A CASE STUDY OF LAKE KINNERET,
Kinneret Limnological Lab., Tiberias (Israel).
For primary bibliographic entry see Field 8I.
W89-02138

LONG-RANGE PLANNING AND PRIORITY AREAS OF GROUNDWATER MANAGEMENT,
Soil Conservation Service, Centreville, MI.
A. G. Herceg, D. R. Mumford, P. Vergot, and L. G. Wolfson.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 399-403.

Descriptors: *Groundwater management, *Management planning, *Priorities, *Michigan, Mapping, Geohydrology, Water resources development, Groundwater quality.

Private industry, environmental groups, federal, regional and local governmental agencies and university personnel concur that communications are a top priority in any groundwater management program. If communications are going to be improved, so must the quality of information. One very useful type of information would be uniform statewide hydrogeologic mapping. Statewide and county-specific mapping to identify where groundwater problems are located should be made available. An integrated approach to water managment should be conceived which could be integrated into ongoing programs developed through universities and the state Departments of Natural Resources and Public Health. Water resource specialists are needed to develop educational programs and support for the agencies involved in this initiative. The groundwater quality issue should be incorporated as part of the total nonpoint source pollution program in Michigan. Some of the actions that could be taken are: (1) develop a permanent subgroup of the Great Lakes and Water Resources Planning Commission (GLWRPC) to address and coordinate water quality activities in the State of Michigan; (2) develop a packet of information to direct groundwater quality concerns to the right sources of information; (3) build agricultural and environmental coalition and support groups; (4) refocus or realign some of the traditional conservation practices of the Soil Conservation Service (SCS) and accelerate the transfer of information that shows the benefits from those practices to the groundwater and not just to surface water; (5) emphasize research and modeling to insure that credible recommendations come from the Cooperative Extension Service and SCS; (6) educate the rural landowners as to their responsibilities to groundwater and the environmental consequences of their actions; and (7) refocus the priorities of agencies and units of government in the state. (See also W89-02196) (Lantz-PTT)
W89-02222

CURRENT TRENDS IN WATER-SUPPLY PLANNING: ISSUES, CONCEPTS, AND RISKS,
For primary bibliographic entry see Field 5F.
W89-02257

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

RECENT SEWAGE FINANCING IN PENNSYLVANIA,
Collings, Legg, Mason, Inc., Philadelphia, PA.
H. Chapman.
Water Pollution Control Association of Pennsylvania Vol. 21, No. 5, p 43, September-October 1988.

Descriptors: *Wastewater facilities, *Pennsylvania, *Financing, Interest rates, Sewer systems, Water treatment facilities, Construction financing, Interest rates, Municipalities.

Borough and township sewage financing for expansion, renovation, or refinancing of sewer lines, sewage treatment plants, and water treatment and distribution facilities in Pennsylvania are listed and financial suggestions are offered based on mid-1988 market conditions. Recent Pennsylvania financing arrangements have been made in Bellefonte Borough, Benzinger Township, Burnham Borough, Sandy Township, Franklin Borough, and Littlestown Borough. It is recommended that borrowers approach several sources to obtain quotes on interest rates because banks in the same area may offer very different rates as a result of money supply and demand. Municipal interest rates in mid-1988 are low compared to the period 1980-1986, but this situation may change after the presidential election. For this reason, borrowing on a long-term basis at present interest rates could prove to be an excellent decision. (Rochester-PTT)
W89-01292

MARKETING SLUDGE COMPOST IN JAPAN,
Japan Sewage Works Agency, Toda. Research and Technology Development Div.
For primary bibliographic entry see Field 5E.
W89-01294

ESTIMATING COSTS MODEL OF DUAL WATER SUPPLY SYSTEMS,
Marsan (Andre) et Associes, Inc., Montreal (Quebec).
For primary bibliographic entry see Field 5F.
W89-01369

CISTERNS FOR WATER CONSERVATION AND FLOOD CONTROL,
French (R.H.), Las Vegas, NV.
For primary bibliographic entry see Field 4A.
W89-01370

VALUE OF COASTAL WETLANDS FOR RECREATION: AN APPLICATION OF TRAVEL COST AND CONTINGENT VALUATION METHODOLOGIES,
Louisiana State Univ., Baton Rouge. Dept. of Economics.
For primary bibliographic entry see Field 6B.
W89-01372

INTERNATIONAL COMPARISON OF WATER PRICES,
International Water Supply Association, London (England).
O. R. Stadtfeld, and K. I. Schlaweck.
Aqua AQUAAA No.4, p 173-177, 1988. 7 fig, 2 tab.

Descriptors: *Water costs, *Prices, *Economic aspects, Comparative studies, Statistics.

Water price comparisons, at both international and national levels, are presented by various institutions and organizations. In most cases average water prices are compared without any reference to background information, such as the structure of the water price, government influence on water price formation, water price development assessment of the respective water prices, in particular when the comparison transcends national borders. The IWSA Committee on 'International Water Statistics' carried out a survey on the situation regarding water prices in its member development and the basis for calculations as well as information on water price formation. The following countries participated in the survey: Belgium, the Federal Republic of Germany, Denmark, United Kingdom, Finland, France, Italy, Luxembourg, the Netherlands, Norway, Austria, Sweden, Switzerland, Spain, and Hungary. (Author's abstract)
W89-01427

WATER CONSERVATION WETLAND VALUES,
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
For primary bibliographic entry see Field 2H.
W89-01833

COST ALLOCATION AT SUPERFUND SITES,
Environmental Resources Management-North Central, Inc., Deerfield, IL.
For primary bibliographic entry see Field 5G.
W89-02009

6D. Water Demand

REPRESENTING HYDROPOWER IN HYDROTHERMAL POWER SYSTEM,
Tennessee Valley Authority, Norris. Engineering Lab.
J. E. Giles.
Journal of Water Resources Planning and Management (ASCE) JWPED5, Vol. 114, No. 5, p 500-516, September 1988. 9 fig, 5 ref, append.

Descriptors: *Mathematical models, *Hydroelectric plants, *Thermal powerplants, *Pumped storage, *Resource allocation, *Hydroelectric power, Management planning, Peak demand, Thermal power, Planning.

A method is developed for evaluating a hydrosystem schedule for a large power system that has both hydro and thermal resources. The method computes thermal costs that accrue while meeting hourly generation requirements by hydro plants, a thermal system, and a pumped-storage plant. The uncertainties associated with thermal-unit operations are dealt with by considering the thermal system as a sum of independent random variables, and then computing their expected generation

levels. One pumped-storage plant is modeled in detail, with complete chronological accounting of reservoir levels and corresponding pump/generation capabilities. The conventional hydro-system minimizes the variation in the hydro-reduced loads. Constraints on the permissible hour-to-hour variation in a thermal unit's generation are also satisfied. The method allocates all power resources so as to approximate their most economical operation while meeting a weekly sequence of hourly power demands. It is designed to rapidly evaluate hydro schedules in models that use a power objective function. An example of the method is given for a week's projected hourly demands. (Author's abstract)
W89-01366

METHOD FOR TREATMENT OF DATA FROM THE INSTREAM FLOW INCREMENTAL METHODOLOGY FOR INSTREAM FLOW DETERMINATION,
Utah State Div. of Wildlife Resources, Salt Lake City.
For primary bibliographic entry see Field 4C.
W89-01737

INVERTEBRATE FISH FOOD RESOURCES OF LOTIC ENVIRONMENTS,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 2H.
W89-01802

6E. Water Law and Institutions

HISTORY OF POINT SOURCE CONTROL OF NUTRIENTS IN PENNSYLVANIA AND OTHER CHESAPEAKE BAY STATES: PART II,
For primary bibliographic entry see Field 5G.
W89-01289

'WHO'S ON FIRST' WITH RIGHT TO KNOW,
S. Pedersen, and B. Danchuk.
Water Pollution Control Association of Pennsylvania Magazine Vol. 21, No. 5, p 33-35, September-October 1988. 3 fig.

Descriptors: *Hazardous materials, *Right-to-know laws, *Regulations, *Pennsylvania, *Management planning, *Occupational health, *Employee protection, Public health, Federal jurisdiction, State jurisdiction, Legislation, Population exposure, Water treatment facilities, Wastewater facilities, Material Safety Data Sheets, Enforcement.

Many Pennsylvania employers must comply with three seemingly parallel laws, the federal Occupational Safety and Health Administration Hazard Communication Standard (HCS), the Pennsylvania Worker and Community Right to Know Act (PA-RTK), and the Environmental Protection Agency's Title III- Community Right to Know (Title III). What these three laws require the employer to do and the differences among them are discussed. Pennsylvania employers, such as cities, municipalities, townships, boroughs, or similar politically-based subdivisions (public employers) are to comply with the full PA-RTK, but not HCS. They may be subject also to parts of Title III. Compliance requirements are somewhat different for private non-manufacturing and manufacturing businesses. All three laws require employers to prepare Material Safety Data Sheets (MSDSs) for all chemicals found in the workplace and to make the MSDSs available to employees. Even if an employer has been in good faith compliance with the PA-RTK law, under the expanded HCS and Title III there are several additional tasks required to achieve compliance: (1) ensure that chemicals in inventory appear on the list of hazardous chemicals and that there is a MSDS for each chemical; (2) make available the workplace hazardous chemical list(s) and maintain the Pennsylvania Hazardous Substance Survey form; (3) post a copy of the HCS or make one available for employee reference; (4) develop a Written Hazard Communication Program and make it available for employee reference; (5) train employees about HCS and chemicals in the workplace; (6) in a multi-employer workplace, make the required pieces of information available to subcontractors; (7) compare the chemical inventory to EPA's list of 'Extremely Hazardous Chemicals' to determine if the employer is subject to Emergency Planning Requirements; (8) collect MSDSs, evaluate the inventory, and make submissions if necessary to local and state agencies; and (9) determine if the company is subject to Toxic Emission Reporting Requirements and submit the necessary documents. (Rochester-PTT)
W89-01291

SOURCE REDUCTION TECHNICAL ASSISTANCE: A PILOT PROJECT AND ITS IMPLICATIONS FOR THE CHEMICAL INDUSTRY,
Massachusetts Dept. of Environmental Management, Boston.
For primary bibliographic entry see Field 5G.
W89-01343

TREATING INDUSTRIAL PLANT WASTEWATER: MEETING TODAY'S COMPLIANCE CHALLENGES,
BCM Engineers, Mobile, AL.
For primary bibliographic entry see Field 5D.
W89-01400

LAW (1987 AMENDMENTS),
Nixon, Hargraves, and Doyle, Rochester, NY.
R. Henrichs.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 748-751, June 1988. 44 ref.

Descriptors: *Literature review, *Water quality control, *Legal aspects, *Legislation, *Regulations, *Water Quality Act, Permits, Enforcement, Financing, Publicly-owned treatment works, Wastewater treatment, Environmental Protection Agency, Federal jurisdiction, State jurisdiction, Storm water, Liability, Penalties.

Literature published in 1987 on legal aspects of water pollution control is summarized under the following headings: new permitting issues, new penalty issues, new publicly-owned treatment works issues, and Water Quality Act (WQA) of 1987 funded EPA/state studies. The 1987 amendments to the WQA strengthen Federal water quality regulation and ultimately will affect every segment of the regulated community. Examples of the provisions are increased civil and criminal liability and new substantive program areas such as state revolving fund and storm water permitting programs. The changes brought about by the 1987 amendments to the WQA are discussed. (Rochester-PTT)
W89-01463

POWER INDUSTRY WASTES,
Tennessee Valley Authority, Knoxville. Environmental Quality Staff.
For primary bibliographic entry see Field 5G.
W89-01490

METAL FINISHING AND PROCESSING,
CH2M/Hill, Reston, VA.
For primary bibliographic entry see Field 5D.
W89-01491

GEORGES BANK - COMMON GROUND OR CONTINUED BATTLEGROUND,
Florida State Univ., Tallahassee. Coll. of Law.
D. R. Christie.
San Diego Law Review, Vol. 23, No. 3, p 491-543, May/June 1986.

Descriptors: *Mnagement planning, *Boundary disputes, *Fish management, *Environmental effects, *Canada, *United States, *Georges Bank, *Resources management, Legal aspects, Water law, Gulf of Maine, Economic aspects, Coastal waters.

The controversies between the United States and Canada concerning boundaries, fish, and transboundary environmental effects of energy development are only the most recent in two centuries of conflicts in the Gulf of Maine-Georges Bank region. Current environmental problems, however, seem to be straining the normally congenial relations between the two countries. As an initial step in assessing management options for the area, this article presents a comparative analysis of environmental assessment and the marine fisheries management and outer continental shelf development regimes of the United States and Canada. Finally, prospects for the future of cooperative management attempts and initial recommendations are addressed. (Author's abstract)
W89-01513

INTERNATIONAL ENVIRONMENTAL LAW AND POLICY: AN OVERVIEW OF TRANSBOUNDARY POLLUTION,
Illinois Univ. at Chicago Circle.
J. W. Kindt.
San Diego Law Review, Vol. 23, No. 3, p 583-609, May/June 1986. 3 append.

Descriptors: *Law of the Sea, *Transboundary pollution, *Ocean pollution effects, *Water pollution, *Legal aspects, *Water law, Environmental effects, Path of pollutants, Policy making, Mediterranean Sea, Baltic Sea, International law, Seas, Ocean dumping, Water pollution sources.

An overview is presented of several of the transboundary pollution issues affecting the Law of the Sea, including defining and categorizing pollution, land-based pollution, and vessel-source pollution. International pollution constitutes a greater threat to the global environment that is readily apparent to most of the international community. Vital areas of the ocean, such as the Mediterranean Sea and the Baltic Sea, may reach their environmental thresholds within a few years and then collapse into a pattern of irreversible despoliation. Global pollution and transboundary pollution have historically been viewed from two major perspectives; namely from the land and from the ocean. More emphasis should be placed upon the ocean as the observational standpoint, because this standpoint is relatively unencumbered by pre-existing disputes involving land-based pollution. This oceanic standpoint also provides for fresh perspectives and allows for innovative policymaking to prevent, reduce and control international pollution. (Roseman-PTT)
W89-01514

RECENT DEVELOPMENTS IN THE LAW OF THE SEA 1984-1985,
E. M. Fry.
San Diego Law Review, Vol. 23, No. 3, p 701-722, May/June 1986.

Descriptors: *Law of the Sea, *International law, *International agreements, *Legal aspects, Treaties, Water pollution control, Boundary disputes, United Nations, Ocean dumping, International commissions, Law of the Sea, Water law, Oil pollution, Radioactive wastes, Navigable waters, Archaeology, Waste disposal, Fisheries.

Additonal ratifications of the United Nations Convention on the Law of the Sea(LOS) occurred in 1985, but the LOS Convention still has not received one-half of the number necessary to bring it into force. Some success was seen in boundary delimitations, fishing treaties, and pollution control, yet news events brought the grim realization that many issues, such as terrorism at sea, the conflict between nuclear-testing nations and those wishing to eliminate such testing, and constraints on the freedom of navigation, are far from resolved. Among the specific topics discussed were: the Beagle Channel dispute, the Northwest Passage, several fishing treaties, whaling, nuclear waste dumping bans, sub-seabed disposal, oil pollution, and marine archaeology. (See also W89-01518) (Roseman-PTT)
W89-01515

Group 6E—Water Law and Institutions

HABITAT CONSERVATION PLANS UNDER THE ENDANGERED SPECIES ACT,
R. E. Webster.
San Diego Law Review, Vol. 24, No. 1, p 243-271, Jan/Feb 1987.

Descriptors: *Legal aspects, *Wildlife habitats, *Endangered Species Act, Conservation, Law, Endangered species, Remedies, Regulations, Aquatic habitats.

Prior to the 1982 amendments of section 10(a) of the Endangered Species Act (ESA), parties not needing any federal permit lacked access to certain regulatory mechanisms of the Act. The revised law provides those parties with the option of preparing a Habitat Conservation Plan (HCP), the approval of which by the Fish and Wildlife Service (FWS) frees the planners from the Act's prohibitions against the taking of endangered species. This Comment examines the statutory requirements for the drafting and approval of HCP's. In examining the flaws of the first three HCP's developed under the new law, this Comment suggests modifications to harmonize section 10(a) with the remainder of the ESA. (Author's abstract)
W89-01516

MARINE POLLUTION: INJURY WITHOUT A REMEDY,
Mississippi Univ. Law Center, University.
M. C. Jarman.
San Diego Law Review, Vol. 24, No. 3, p 603-626, May/June 1987.

Descriptors: *Federal jurisdiction, *Marine environment, *Water pollution, *Legal aspects, Economic aspects, Legislation, Environmental effects, Water pollution effects, State jurisdiction, Remedies, Oil pollution, Legislation.

Pollution of coastal and ocean waters is a complex and serious problem. Many contaminants reaching the ocean are harmful to marine organisms. Pollution affects the marine environment at all levels, from marine organisms to human beings. Along with the environment, the economy suffers injury because of damage to food sources. The role of federal courts as a forum for redress of damages suffered from the pollution of coastal and ocean waters is discussed and conflicting state and federal common law and statutory remedies for marine pollution are examined. With the exception of the Offshore Oil Pollution Compensation Fund, no federal remedies appear to be available to parties injured by marine pollution. In the face of the federal judiciary's retreat, it is concluded that Congress and state legislators must take affirmative steps to preserve remedies that traditionally have been available to injured persons. (Author's abstract)
W89-01517

RECENT DEVELOPMENTS IN THE LAW OF THE SEA 1986,
H. E. Brown.
San Diego Law Review, Vol. 24, No. 3, p 701-726, May/June 1987.

Descriptors: *Water law, *Legal aspects, *United Nations, *Water pollution, *Law of the Sea, Boundary disputes, Sea mining, Treaties, Fishing, Plastics, Ocean dumping, Territorial disputes, Oil spills, Liability.

In 1986, Resolution II of the United Nations Convention on the Law of the Sea (LOS Convention), dealing with deep seabed mining was adopted. While the United Nations General Assembly reaffirmed its support of the LOS Convention, only seven nations ratified or acceded to the Convention in 1986. Some success was seen in fishing treaties and protection of marine mammals. Renewed concern surfaced regarding pollution of the oceans. Specific issues discussed include deep seabed mining, protection of marine species, plastics pollution, ocean incineration, oil spill liability, and territorial disputes. (See also W89-01515) (Author's abstract)
W89-01518

SAND RIGHTS: USING CALIFORNIA'S PUBLIC TRUST DOCTRINE TO PROTECT AGAINST COASTAL EROSION,
M. A. Corfield.
San Diego Law Review, Vol. 24, No. 3, p 727-750, May/June 1987.

Descriptors: *Beaches, *Beach erosion, *Legal aspects, *Sand, *Recreation, Sand rights, Public Trust Doctrine, Public beaches, Economic aspects, Dam effects.

Since the 1950s many rivers and streams running from inland areas to the California coastline have been dammed for water supply and flood control. The reduced streamflow has resulted in much less sand being transported to California beaches to replace sand lost through coastal erosion. Consequently, much of the coastline is eroding at an alarming rate. The public trust doctrine provides that the tidelands are held in trust by the state for the benefit of the public. Most legislation regarding the public trust doctrine has focused on ownership interests in public trust resources. This comment argues for a system of public rights to the sand that makes up public beaches. A system of sand rights would provide a basis for judicial enforcement of the state's fiduciary duty to maintain beaches in the face of threats to sand supply. (Author's abstract)
W89-01519

LANDS AND NATURAL RESOURCES,
S. L. Schmelter.
Denver University Law Review, Vol. 64, No. 2, p 295-327, 1987.

Descriptors: *Water law, *Legal aspects, *Navigation, *Water use, *Land use, *Resources management, Boundary disputes, American Indians, Court decisions.

During the period 1980-1986, the Tenth Circuit Court of Appeals handed down five lands and natural resources opinions which merit review. The first case revisits a controversial Indian reservation boundary dispute. A pair of cases address navigational waters issues: the first concerns the impact of navigational servitude on Indian lands, the second deals with a quiet title argument. The fourth case resolves a mineral patent question. The final case surveyed deals with an environmental impact statement related to a major water diversion project. These five lands and natural resources decisions reflect an inconsistent approach taken by the Tenth Circuit: two of the cases adhere to the Tenth Circuit's traditional approach in protecting regulatory power which governmental agencies wield over lands and natural resources, while three of the cases demonstrate a departure from the traditional deference to governmental authority. (Author's abstract)
W89-01527

ENVIRONMENTAL CONTROLS OVER GEOTHERMAL ENERGY EXPLOITATION,
Melbourne Univ., Parkville (Australia). School of Law.
For primary bibliographic entry see Field 6G.
W89-01528

PRIVATE RIGHTS AND THE PUBLIC TRUST: OPPOSING LAKESHORE FUNNEL DEVELOPMENT,
D. A. Kagan.
Boston College Environmental Law Review BCERDX, Vol. 15, No. 1, p 105-134. 1987.

Descriptors: *Lakes, *Environmental effects, *Recreation demand, *Housing, *Water rights, *Water law, *Legal aspects, Water pollution, Fish, Wildlife, Regional development, Public Trust Doctrine, Common law, Water use.

The author suggest a common law doctrine that a riparian owner can raise in opposition to funnel development. In states where lakes are owned by the public and held in trust by the state, members of the public may sue the state under the public trust doctrine for violating the trust. The public trust doctrine is still developing, and cases applying the doctrine in opposition to funnel development have not been reported. The author discusses why the public trust doctrine is a valid legal basis for opposing a developer's plans for funnel development. Funnel development projects allow a developer to capitalize on the expanding market for vacation homes with water access. The projects yield significant profits for developers. Funnel developments, however, can have significant detrimental effects on lakes. They can cause serious environmental degradation through increasing the intensity of recreational use and by introducing various pollutants to the waterway. This degradation can cause an irreversible decline in water quality, accompanied by declining populations of fish and wildlife. The author concludes that courts should permit riparian owners to bring suit based on the public trust doctrine in opposition to funnel development. (Roseman-PTT)
W89-01529

KEY TO PREVENTING CONTAMINATION OF GROUNDWATER BY PETROLEUM PRODUCTS: FLORIDA'S SUPER ACT,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5G.
W89-01531

USE OF RISK ASSESSMENT TO DEFINE A CORRECTIVE ACTION PLAN FOR LEAKING UNDERGROUND STORAGE TANKS,
Gradient Corp., Cambridge, MA.
M. F. Conway, and S. H. Boutwell.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 19-40, 3 fig, 4 tab, 11 ref.

Descriptors: *Storage tanks, *Cleanup operations, *Groundwater pollution, *Water pollution prevention, *Project planning, Hazardous wastes, Leakage, Risks, Site selection, Case studies, Waste disposal, Massachusetts, Benzenes, Public health, Water pollution effects, Path of pollutants.

Under Subtitle I of the Hazardous and Solid Waste Amendments of 1984 (RCRA), EPA is required to develop and implement a comprehensive regulatory program for underground storage tanks (UST). UST systems have been a major source of concern due to releases of petroleum and hazardous substances to the environment, particularly groundwater. EPA has recently published a proposed rule under Subtitle I for technical requirements involving leak detection and prevention, financial responsibility, and corrective action for all USTs containing regulated petroleum and hazardous substances. This paper evaluates EPA's proposed risk assessment process for defining a corrective action program, and provides an integrated site investigation/risk assessment approach to address development of clean-up criteria. A UST release exposure/risk assessment case study is provided to illustrate this approach to develop criteria for the cleanup of petroleum product constituents in the subsurface environment at a UST site in a suburban community in Massachusetts. (See also W89-01530) (Author's abstract)
W89-01533

STUDY OF CURRENT UNDERGROUND INJECTION CONTROL REGULATIONS AND PRACTICES IN ILLINOIS,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 5E.
W89-01579

TREATMENT AND DISPOSAL TECHNOLOGIES FOR LIQUID HAZARDOUS WASTES ALTERNATIVES TO SUBSURFACE INJECTION,
Engineering-Science, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5E.
W89-01594

ECONOMIC IMPACTS OF ALTERNATIVE TECHNOLOGIES FOR TREATMENT AND DISPOSAL OF LIQUID HAZARDOUS WASTES,
Engineering-Science, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5E.
W89-01595

FOCUS ON RESEARCH NEEDS,
Texas Univ. at Austin.
For primary bibliographic entry see Field 5E.
W89-01597

CYANIDE CONTAMINATION NEAR ELK CITY, IDAHO: THE REGULATORY IMPLICATIONS,
Idaho State Dept. of Health and Welfare, Boise.
For primary bibliographic entry see Field 5B.
W89-01685

USE OF WETLANDS FOR WASTEWATER TREATMENT AND EFFLUENT DISPOSAL: INSTITUTIONAL CONSTRAINTS,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5D.
W89-01855

ENVIRONMENTAL IMPACT ASSESSMENT,
Ministry of Works and Development, Wellington (New Zealand).
For primary bibliographic entry see Field 6G.
W89-01874

TOWN AND COUNTRY PLANNING,
Ministry of Works and Development, Dunedin (New Zealand).
For primary bibliographic entry see Field 6A.
W89-01875

WATER RIGHTS AT THE NATIONAL AND REGIONAL LEVEL,
Ministry of Energy, Wellington (New Zealand). Electricity Div.
J. C. Town, and D. C. Best.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 49-58, 2 tab, 6 ref.

Descriptors: *Water rights, *Regional planning, *National planning, *New Zealand, Water law, Institutions, Water policy, Water quality regulations.

Natural waters in New Zealand cannot be utilized for hydroelectric power generation without appropriate water rights. This chapter outlines the procedures adopted for the issue of Crown and local water rights. Mechanisms for setting maximum and minimum lake levels and river minimum flows are also presented. The responsibilities and composition of Regional Water Boards and national water quality classification standards are detailed. The role of the National Water and Soil Conservation Authority in the granting of Crown water rights is also explained. (See also W89-01871) (Lantz-PTT)
W89-01876

WILD AND SCENIC RIVERS: CONSERVATION AND NATURAL WATER AMENITIES,
Ministry of Works and Development, Wellington (New Zealand).
For primary bibliographic entry see Field 6F.
W89-01877

SUBMISSIONS, RECOMMENDATIONS AND OBJECTIONS: THE NATURE CONSERVATION COUNCIL'S EXPERIENCE,
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
C. W. Burns, and P. D. Crisp.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 75-86, 3 tab, 6 ref.

Descriptors: *Natural waters, *New Zealand, *Water conservation, *Water resources development, *Regulations, Hydroelectric plants, Site selection, Roads, Public relations, Statutes, Management planning.

The Nature Conservation Council's files on hydroelectric power development proposals in New Zealand over the past 24 years are a valuable historical record which it willingly shares with other organizations, within the Government and outside it. In 1980 the council crystallized its accumulated knowledge and experience related to hydroelectric power development and the conservation of biological, landscape and other values into the policy statements which appear in this article. Many of the developments associated with any power scheme, not just hydro-schemes, come under investigation by the Nature Conservation Council. These include roading and the siting of transmission lines, substations and communications towers. Where possible, the procedure of discussion at the planning stage and site inspection is followed. Over the years considerable progress has been made in ensuring that biological and landscape values are protected. Greater public awareness of nature conservation values has contributed to this success also. However, the protection of these values to the extent recommended by the council, or to the satisfaction of all individuals or groups with conservation interests, has not always been achieved. In the council's experience direct confrontation generally achieves little by way of protecting landscape and biological values. The statutory planning procedure and hearings, as presently conducted, sometimes achieve more but are costly in time, money and manpower. By far the most satisfactory solutions have been achieved through discussions with interested parties at the earliest stages of planning and, for large-scale, long-term projects, a continuing involvement throughout development until the project is completed. (See also W89-01871) (Lantz-PTT)
W89-01878

AQUATIC NOXIOUS PLANTS LEGISLATION,
Ruakura Soil and Plant Research Station, Hamilton (New Zealand).
L. M. Harper.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 87-93, 3 ref.

Descriptors: *Aquatic plants, *Legislation, *New Zealand, *Aquatic weed control, *Aquatic weeds, Weeds, Economic aspects.

A weed interferes, through some characteristic of its biology, life habit or habitat, with human use of the environment. The use of legislation to aid the control of such plants has a long history in New Zealand. The main emphasis has been on the control of terrestrial plants which affect the farming industry, and only recently has there been a requirement for legislation to aid in aquatic plant control. This chapter discusses the development of a legislative and administrative framework to deal with nuisance aquatic plants. Limitation of the Noxious Plants Act are: (1) a lack of knowledge of aquatic plant problems and their control, by both field personnel and the noxious plants administration. There was also a lack of water managers in the administration structure; (2) the coordination of control work. Aquatic weed problems are commonly catchment-bound and control must therefore be coordinated on a catchment basis; and (3) the definition of the occupier of waterways had not been clearly resolved and stated. Without the definition of occupier, central to the Noxious Plants Act, it was impossible to require a financial commitment or enforce any aquatic plant control measures, using the legislation. (See also W89-01871) (Lantz-PTT)
W89-01879

SYSTEMS ECOLOGY AND ENVIRONMENTAL LAW: DO THEY SPEAK THE SAME LANGUAGE,
Envirosphere Co., Bellevue, WA.
R. M. Emery, and G. G. Mattson.
IN: Aquatic Toxicology and Environmental Fate: Ninth Volume. A Symposium Sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate, Philadelphia, PA, April 14-16, 1985. ASTM Special Technical Publication 921, 1986. p 25-41, 103 ref.

Descriptors: *Ecosystems, *Environmental law, *Legal aspects, *Environmental effects, Aquatic toxicology, Regulations, Ocean Discharge Criteria, Aquatic environment.

Differences between the ecosystem protected by federal laws and the ecosystem that can be defined by systems ecologists are examined. Today, there are a number of laws that make specific reference to 'aquatic ecosystems,' often in terms of their structure, function, integrity, and stability. One example is the Ocean Discharge Criteria (ODC) regulations for issuance of a National Pollution Discharge Elimination System (NPDES) permit. The applicant is required to 'determine the nature and degree of effect that the proposed discharge will have, both individually and cumulatively, on the structure and function of the aquatic ecosystems and organisms.' These ODC/NPDES regulations also protect against 'unreasonable degradation' defined as 'significant adverse changes in ecosystem diversity, productivity, and stability...' Our environmental laws assume that ecosystems will have legally definable behaviors, interpretable in terms of stability and disturbance. But the question then becomes whether the science of systems ecology is sufficiently advanced and wells supplied with quantitative information to provide these interpretations. Or, whether the language of the law presupposes a level of sophistication not yet formalized in ecological exegesis. This paper examines where the state of the art of systems ecology meets the expectations of the law, and where it does not. (See also W89-01892) (Author's abstract)
W89-01895

ENVIRONMENTAL CONDITIONS FOR WATER RESOURCES PROJECTS,
For primary bibliographic entry see Field 6G.
W89-01991

WATER REUSE AND RECYCLING IN INDUSTRY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-02039

COMMUNITY INVOLVEMENT: THE CATALYTIC FACTOR IN WASTE MANAGEMENT,
Winsor Associates, Ardmore, PA.
E. W. Winsor.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 373-377, 7 ref.

Descriptors: *Waste management, *Management planning, Local jurisdiction, Public participation, Site selection, Political aspects.

A successful community relations program must have several characteristics. First, it must involve a commitment from the management team to work openly with the public. Second, it must be sufficiently flexible so that the public can be brought into the process early enough and in clearly-defined ways so that local officials and leaders feel that they have control over what is happening in their community. Third, despite the criticisms and comments, which can sometimes border on harassment, the siting and operational processes must be open to public scrutiny. The operator of a waste management facility must be prepared to operate in a goldfish bowl. The firm that is able to develop such a community relations and communications program will increase the probability of its success immeasurably. Such a program may well provide the catalyst necessary to successfully site and operate waste management facilities. (See also W89-02006) (Lantz-PTT)
W89-02041

WISCONSIN GROUNDWATER QUALITY STANDARDS: CAN WASTEWATER LAND TREATMENT SYSTEMS MEET THEM,

Wisconsin Dept. of Natural Resources, Madison. Div. of Environmental Standards.
D. K. Sauer, and S. Scott.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 767-774, 1 fig, 6 tab, 9 ref.

Descriptors: *Water pollution prevention, *Wisconsin, *Groundwater quality, *Land disposal, *Standards, Wastewater disposal, Regulations, Legislation, Nitrogen, Soil types, Chlorides, Dissolved solids, Anions, Groundwater pollution.

Chapter NR 140, Groundwater Standards, of the Wisconsin Dept. of Natural Resources, is a complex rule which specifies that numerical groundwater standards apply at specific locations. Current wastewater land application systems have generally been effective in limiting the carbonaceous oxygen demand requirements in the groundwater. For those systems located on sandy-coarse grained soil types, nitrogen application rates need to be limited to the nitrogen requirements of the growing cover crop. This should reduce the nitrogen increases in the groundwater found to be occurring currently. Total dissolved solids and chlorides are two groundwater parameters which are often elevated for both slow rate and high rate land treatment systems. Chloride impacts can be minimized by segregated high chloride containing wastes from the land treatment system. Groundwater standard exceedances for total dissolved solids will probably occur at most sites regardless of the quality of applied wastewater. These exceedances, however, can be minimized by improving the operation and maintenance of the land treatment system and reducing the hydraulic application rates. Analytical groundwater models are being used to further document chloride and other anion impacts on the groundwater. Reliability of these models needs to be improved by better definition of input parameters. Initial findings from the groundwater models have confirmed existing information that the high rate land disposal systems (rapid infiltration system) have a high potential to impact anion-cation groundwater concentration. (See also W89-02006) (Lantz-PTT)
W89-02080

INDUSTRIAL WASTES AND SOIL LEAD CONCENTRATION AS A BASIS FOR REMEDIAL OR OTHER ACTION,

Missouri Univ.-Rolla. Environmental Research Center.
B. G. Wixson, A. Ghazifard, and B. E. Davies.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 787-791, 3 fig, 1 tab, 14 ref.

Descriptors: *Toxic wastes, *Industrial wastes, *Standards, *Soil contamination, *Lead, Remedies, Toxicity, Hydrogen ion concentration, Landfills, Waste disposal.

Realistic guidelines are needed to identify lead levels in soil which imply contamination or indicate the need for remedial action. Based on existing scientific information and interim soil lead guidelines used to protect human health in Britain and Canada, it seems logical to propose 1,000 micrograms/g soil lead for industrial (open spaces or parks) purposes and 500 micrograms/g lead for soils which are used for growing vegetables for consumption where maximum contact exposure to children might occur, such as in residential areas. Guidelines must take pertinent factors into account such as having a soil pH above 5.6, the influence of organic matter, the presence of chelating compounds and site specific geologic conditions that might affect metal mobility. The use of soil lead sample patterns to determine possible areas for remedial action is illustrated here by research on a former landfill site near Kansas City, MO. (See also W89-02006) (Lantz-PTT)
W89-02083

HEAVY METALS IN WASTEWATER AND SLUDGE TREATMENT PROCESSES. VOLUME I: SOURCES, ANALYSIS, AND LEGISLATION.

For primary bibliographic entry see Field 5A.
W89-02097

POLLUTION CONTROL LEGISLATION,

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
P. W. W. Kirk.
IN: Heavy Metals in Wastewater and Sludge Treatment Processes. Volume I: Sources, Analysis, and Legislation. CRC Press, Boca Raton, Florida, 1987. p 65-103, 28 tab.

Descriptors: *Water pollution control, *Legislation, *Heavy metals, *Europe, Regulations, Public health, Arsenic, Cadmium, Chromium, Mercury, Lead, Selenium, Industrial wastewater, Sludge disposal, Wastewater disposal, Wastewater treatment, Standards.

The primary objective of the guidelines and legislation reviewed is to protect public health via the promulgation and enforcement of standards. Protecting raw water quality represents a change in emphasis which has occurred as a direct result of the increasing indirect reuse of water for potable supply. This change is reflected in the directive promulgated by the Council of the European Communities (CEC) which specifies maximum metal concentrations in raw water intended for potable water abstraction at varying levels of treatment. The derivation of potable water standards is open to the varying interpretation of available data by each national or international authority. For the most regulated metals, namely As, Cd, Cr, Hg, Pb, and Se, the World Health Organization (WHO) Guidelines maximum concentrations are identical to those stipulated by the CEC, whereas the U.S. EPA standards are less stringent for Cd and Hg, and the U.S.S.R. standards are more stringent for Se, but less stringent for Pb. Protection of the aquatic environment has prompted the CEC and EPA to promulgate discharge limits for certain metal-bearing industrial effluents. Discharges of Hg by the chlor-alkali industry for example, are subject to more stringent limits in the U.S. The concept of limit values for metals in effluents, although favored by most member states, has not been adopted by the U.K. whose system is based on the application of Environmental Quality Objectives (EQOs). The EQO approach has been reflected in the CEC directives concerning Hg and Cd discharges which incorporate water quality objectives applicable to fresh water, estuarine, and seawater. The stability/immobility of heavy metals during sludge treatment and at the ultimate disposal site are critical in determining the safety of the disposal operation. Heavy metals present in sewage sludges give cause for concern in four areas: (1) Human health, when sludge is applied to agricultural land or disposed to sea; (2) Adverse effects on biological sludge treatment; (3) Adverse effects on the receiving environment; and (4) Effects on surface and groundwater quality when sludge is applied to land. As a consequence of these concerns, guidance on the disposal of sewage sludge to land and in the marine environment has been given in the U.K. (See also W89-02097) (Lantz-PTT)
W89-02100

OVERVIEW OF THE EFFECTIVENESS OF CANADIAN CHLOR-ALKALI MERCURY REGULATIONS,

Department of the Environment, Ottawa (Ontario).
For primary bibliographic entry see Field 5G.
W89-02135

UNITING HABITAT QUALITY AND FISHERY PROGRAMS IN THE GREAT LAKES,

Great Lakes Fishery Commission, Ann Arbor, MI.,
For primary bibliographic entry see Field 5G.
W89-02141

ADMINISTRATION OF THE FISH CONTAMINANT PROGRAM IN A DECENTRALIZED STATE AGENCY,

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
L. A. Nielsen.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 251-264, 1 fig, 1 tab, 5 ref.

Descriptors: *Water pollution control, *Fish, *Wisconsin, *Project planning, *Water pollution effects, *State jurisdiction, *Institutions, Management planning, Fisheries, Fishing, Public participation.

Isolated problems with chemical contamination of Wisconsin fish require the Department of Natural Resources to issue fish consumption advisories for recreational anglers and other fish consumers. Because the department is decentralized, many groups share responsibility for the advisories. The absence of clear roles for these groups in the past has resulted in poor internal communication, nonrational data interpretation and contradictory public statements. A year-long evaluation of the program has produced a new operating procedure designed to assure both agency-wide review of data and decisions, and public announcements that are timely and consistent. The new procedure is a 4-stage process that features redefinition of the sampling year, annual analysis of data (except in emergencies), and extensive liason between field and staff and between fishery and water resources managers. (See also W89-02137) (Author's abstract)
W89-02150

LEGAL AND PUBLIC INFORMATION CHANGE NEEDED,

National Fisheries Inst., Inc., Washington, DC.
For primary bibliographic entry see Field 5G.
W89-02152

MICHIGAN'S PROCESS FOR REGULATING TOXIC SUBSTANCES IN SURFACE WATER PERMITS,

Michigan Dept. of Natural Resources, Lansing. Surface Water Quality Div.
For primary bibliographic entry see Field 5G.
W89-02154

WASTE: THE ENIGMA OF THE 80'S,

Limno-Tech, Inc., Ann Arbor, MI.
For primary bibliographic entry see Field 6A.
W89-02156

WEALTH GENERATOR OR ENVIRONMENTAL PROTECTOR. THE APPROACH OF A CHEMICAL COMPANY TO PROCESS AND PRODUCT DEVELOPMENT UNDER INCREASING ENVIRONMENTAL PRESSURES,

Imperial Chemical Industries Ltd., Brixham (England).
J. R. Lawrence.
IN: Toxic Contamination in Large Lakes. Volume III: Sources, Fate, and Controls of Toxic Contaminants. Lewis Publishers, Chelsea, Michigan, 1988. p 121-149, 5 fig, 4 tab, 12 ref.

Descriptors: *Water pollution prevention, *Chemical industry, *Management planning, Environmental protection, Imperial Chemical Industries, England, Economic aspects.

The chemical industry's task is to produce products that world markets want and in doing so to make sufficient profit to reward those who provide the capital, to ensure its continuing development and also to do so in harmony with society. It is in this last respect that environmental pressures must be accommodated. Policies cannot respond to environmental constraints alone but must achieve a balance between costs, product performance and environmental performance. Good management and new technology provide a pay-off that is shared in these three dimensions. It is dangerously

misleading to claim that tighter environmental controls and more stringent legislation is necessarily beneficial economically. The benefits of an improved environment are for the most part not quantifiable in money terms. In policies and decisions, a value judgement is affected in which environmental performance is traded against cost and product performance. Imperial Chemical Industries (ICI), in Brixham, England, has achieved an enviable reputation for its approach to environmental matters and received a number of awards for processes and products that reflect this approach. In developing new sites in the UK, ICI has responded to the long established and extensive laws for planning control. In addition, the European Economic Commission has produced a directive requiring a formal Environmental Impact Assessment for major new developments. ICI management believes that of greater importance is the internal management process whereby significant environmental, in the very broadest sense of the word, impact is explored in order to maximize the chance of a successful project that is accepted by the community. These concepts are developed and illustrated by reference to specific projects, processes and products. (See also W89-02155) (Author's abstract)
W89-02163

TRANSBOUNDARY MANAGEMENT OF LARGE LAKES: EXPERIENCE WITH THE GREAT LAKES OF NORTH AMERICA,
Northwestern Univ., Evanston, IL. Center for Urban Affairs and Policy Research.
L. Botts.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 47-61, 6 ref.

Descriptors: *Great Lakes, *Canada, *International commissions, *Treaties, *Water management, Legal aspects, Channels, Lakes, Public policy, History.

The Great Lakes of North America divide the continent politically but unite the United States and Canada in transboundary resource management by treaty. For three-quarters of a century, the 1909 Boundary Waters Treaty has provided a model for peaceful cooperative resource management across an international border. For the Great Lakes, the treaty provides procedures for bi-national management of water quantity and water quality. Concern about quantity led to negotiation of the treaty with a provision that later provided the framework for the Great Lakes Water Quality Agreement. The formal responsibility for administering the treaty and the Great Lakes Agreement rests with the International Joint Commission of Canada and the United States (IJC). This uniquely independently bi-national agency was established by the 1909 Treaty. The Treaty's designers mainly considered management of levels and flows through certain connecting channels. Still, the institutions and processes they established provided precedents that would be followed later in the Great Lakes Water Quality Agreement. Perhaps the greatest testimony to their foresight is the fact that the IJC has split along national lines in fewer than half a dozen of over 100 decisions in almost 75 years. Both boards submit annual reports to the IJC. Both the board reports and the IJC reports serve several purposes. First, they provide a historical record of activities under the Agreement. Second, the annual reports, particularly from the Science Advisory Board and its subsidiary units, provide a forum for technical and scientific experts to raise policy issues for consideration. The third function is to make the boards and indirectly the governments accountable to the public. (See also W89-02176) (Lantz-PTT)
W89-02179

TRANSBOUNDARY MANAGEMENT OF LAKE GENEVA,
Republic et Canton de Geneve, Suisse. Dept. des Travaux Publics.
P. A. Spoerli.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 63-76, 6 fig.

Descriptors: *Lake Geneva, *International commissions, *France, *Switzerland, *Water management, *Water pollution prevention, *Regulations, Water quality control, Environmental protection, Fertilizers, Wastewater treatment, Phosphates.

The four main tasks mentioned in the Agreement establishing the Commission on Lake Geneva water quality are: (1) To organize and have all research carried out necessary to the understanding of the nature, the importance and the sources of pollution and to exploit the results of this research; (2) To recommend to the contracting governments what measures to take to curb existing pollution and prevent all future pollution; (3) The commission can prepare the elements of an international regulation on the subject of water quality in Lake Leman; and (4) It examines any other issue pertinent to water pollution. The International Commission has no direct power of decision. The only thing it can do is recommend to its member states what action should be taken. It is up to these states to implement these recommendations within their jurisdiction. For example, the 1985 recommendations were: (1) to extend the agreement on phosphate reduction, because of its positive effects; (2) to generally promote the use of detergents without phosphates; (3) to promote the construction of separate sewage collection systems and to repair and upgrade existing sewerage systems; (4) to reinforce quality control of effluents of sewage treatment plants by providing the responsible organizations with sufficient resources; and (5) to undertake all efforts to reduce diffuse pollution by encouraging rational use of fertilizer and manure and by promoting ways of cultivation that will reduce soil erosion. The application of these recommendations will take some time, depending how motivated the different states are. (See also W89-02176) (Lantz-PTT)
W89-02180

INDUSTRIAL SITING IN A DEVELOPING COUNTRY THE CASE OF ARGENTINA - ITS CONTEXT - THE ENVIRONMENTAL DIMENSION, HAZARDOUS WASTE AND LARGE LAKES,
Indiana Univ. at Bloomington.
For primary bibliographic entry see Field 6G.
W89-02184

STRATEGIES FOR CONTROL OF NON-POINT SOURCE POLLUTION,
American Farmland Trust, Washington, DC.
For primary bibliographic entry see Field 5G.
W89-02186

INTRODUCING SCIENTIFIC ANALYSIS TO PUBLIC POLICY - AN INTERNATIONAL PERSPECTIVE,
Dartmouth Coll., Hanover, NH.
K. von Moltke.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 179-188.

Descriptors: *Institutions, *Public policy, *International commissions, *Lake management, *Environmental protection, Research priorities, Water pollution prevention, Policy making.

Policy in relation to natural resources is unique among policy areas in its focus on goods which have no voice of their own. But policy is made by people, and through the articulation of goals and social means; to develop environmental policy it is essential to formulate the changes which occur in nature in an articulate manner. It is extremely difficult to obtain assessments of research with respect to a transjurisdictional ecosystem, such as like large lakes, because of the difference which may be obtained in the various jurisdictions. The major difficulty lies not in the absence of relevant research, nor in language problems but in the fact that the policy-making institutions for large lakes are either indeterminate or poorly known. Consequently, it can be very difficult to make assessments which are truly policy relevant. Without a clearly defined well functioning policy-making context, it is also impossible to develop effective institutions for policy-relevant research assessments. All attempts at such institutional development at the international level have thus far had only modest success. In practice, policy-oriented research assessments for international policy issues must be undertaken ad hoc, much as international policy-making itself occurs. The two examples of cooperative ventures by academies, the joint venture of the British Royal Society, and the Swedish academy and the assessment of the Great Lakes Water Quality Agreement by the NAS and the Canadian Royal Society - are probably examples of the kind of assessments which it will be necessary to undertake in advancing complex policy issues in transjurisdictional situations. (See also W89-02176) (Lantz-PTT)
W89-02187

SETTING PRIORITIES FOR GREAT LAKES ENVIRONMENTAL QUALITY RESEARCH,
National Oceanic and Atmospheric Administration, Rockville, MD. Ocean Assessments Div.
For primary bibliographic entry see Field 6A.
W89-02188

ROLE OF THE NEWS MEDIA IN DETERMINING PUBLIC POLICY FOR THE GREAT LAKES,
Globe and Mail, Toronto (Ontario).
For primary bibliographic entry see Field 6A.
W89-02189

INTERNATIONAL AGREEMENTS AND STRATEGIES FOR CONTROLLING TOXIC CONTAMINANTS,
Butler Univ., Indianapolis, IN. Holcomb Research Inst.
O. L. Loucks, and H. A. Regier.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 235-247, 3 ref.

Descriptors: *International agreements, *Water pollution control, *Water quality control, *Toxic wastes, *Hazardous wastes, Toxicity, Data acquisition, Data interpretation, Information exchange, Public relations, Public policy.

There is little that can be recognized as international strategy for controlling contaminants. An important development at the level of strategy by the political leadership is the announcement of a Cooperative Agreement in controlling Toxics in the Great Lakes by the Governors of the Lake States and Provincial Premiers in May 1986. Two important joint institutions were established through the Agreement: the Water Quality Board and the Science Advisory Board. The main responsibilities of these two joint institutions can be summarized as follows: (1) Data collection, analysis and distribution; (2) Advice and recommendations by the joint institutions; (3) Assistance in the coordination of joint activities; (4) Investigations; and (5) Public information. In viewing the progress to date under the Agreement and through the joint institutions, the NRC/RSC Committee (1985) made the following major findings: (1) The past century can be shown to have had a record of resource degradation in the basin, intruding more and more deeply into ecosystemic processes, expanding in area from local effects, to whole-lake effects, to the whole basin, and extending in duration of the impact from brief to almost irreversible; (2) The causes of these impairments are now more complex and have become less evident; and (3) The sequence of degradation, subsequent corrective measures, which are only partially effective, and the prospects of new environmental impacts have not yet been brought under control. (See also W89-02176) (Lantz-PTT)

W89-02191

ECOSYSTEM MANAGEMENT: OVERCOMING JURISDICTIONAL DIVERSITY THROUGH LAW REFORM,
Canadian Environmental Law Research Foundation, Toronto (Ontario).
P. Muldoon.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 249-265, 19 ref.

Descriptors: *Environmental law, *Environmental management, *Legal aspects, *Great Lakes, *Environmental protection, Jurisdiction, Administration, Management planning, Public policy.

The quest for uniform rights concerning public participation is only one means to further the implementation of ecosystem management; a single dimension in a multi-faceted approach needed to address the problem of jurisdiction diversity. Other legal initiatives must also be researched, such as the study the Canadian Environmental Law Research Foundation (CELRF) initiated following the cross-border litigation study. Reform of the legal impediments to cross-border litigation within the Great Lakes ecosystem can take two general routes. The first route would be to advocate that each jurisdiction remove those specific common law and statutory provisions identified as barriers to cross-border litigation. The second route is to develop a 'model statute' which includes provisions that would vest each resident of the ecosystem with a basic array of environment rights - the 'Ecosystem Rights Act'. The Ecosystem Rights Act would incorporate the following principles: (1) courts and administration tribunals within ecosystem jurisdictions would consider the ecosystem as a single jurisdictional unit in matters relating to its protection, conservation, and enhancement; (2) every person residing within an ecosystem jurisdiction would have equal access to the courts and administrative tribunals within the ecosystem to participate in proceedings relating to the protection, conservation, and enhancement of the ecosystem, and share the same rights to relief as any other person of the jurisdiction where the proceeding was commenced; (3) in any proceeding before a court or tribunal affecting the protection, conservation, or enhancement of the ecosystem, the court- or tribunal is empowered to consider the basin-wide impacts of its actions; (4) courts have jurisdictions over any polluter within the ecosystem and will not bar a claim solely because it related to injury to land within the ecosystem but outside the territorial limits of the jurisdiction; (5) every person within the ecosystem has a right to bring action against any person for environment injury or an order to restrain any activity that may cause harm to the ecosystem or violate any environmental law, standard or permit, even though that person does not allege any personal injury. (See also W89-02176) (Lantz-PTT)
W89-02192

LAKE RESOURCES AND FISHERIES UTILIZATION IN HUBEI PROVINCE,
Hubei Aquatic Products Science Research Inst. (China).
For primary bibliographic entry see Field 2H.
W89-02193

ENVIRONMENTAL IMPACTS OF LARGE SCALE HOG PRODUCTION FACILITIES,
Michigan State Legislature, Lansing. Legislative Science Office.
For primary bibliographic entry see Field 5G.
W89-02204

DRINKING WATER STANDARDS: THEIR DERIVATION AND MEANING,
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5G.
W89-02210

OVERVIEW OF MICHIGAN GROUNDWATER LAW,
Michigan State Univ., East Lansing. Dept. of Resource Development.
P. M. Ryan, and L. L. Leighty.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 305-322, 2 append.

Descriptors: *Michigan, *Groundwater, *Water law, Water use, Groundwater withdrawal, Legal aspects, Water supply, Drinking water, Law enforcement, State jurisdiction, Federal jurisdiction, Costs.

Michigan case law establishes a reasonable use rule for withdrawals of groundwaters by property owners. Quantities of water withdrawn are not without limit. It is probable that this limitation will be applied to uses on the land from which the water is withdrawn, as well as for uses distant from the well site, if and when the Michigan Supreme Court accepts a case on these facts. Only one Appeals Court case (Maerz v. U.S. Steel Corp.) has decided this issue, and all Supreme Court cases have involved off-site uses with a significant public interest, namely a public drinking water supply. On the quality side, it seems that the groundwaters of Michigan are aptly protected by statutory and common law. The significant penalties and imprisonment, serve as the most significant protective measure. Additionally, such penalties encourage prevention of contamination as a sound business practice. Where contamination has occurred, there are remedial measures at the state and federal level to enforce cleanup; on-site cleanup is preferred under the Superfund regulations. While a few more cases may reach appellate courts, most activity is likely to involve administrative law and reach appeal only in rare cases. The costs and potential penalties, compared with the strength of the statutes and balancing of the equities, will preclude most challenges by alleged violators. (See also W89-02196) (Lantz-PTT)
W89-02216

WISCONSIN PROGRAMS ON GROUNDWATER POLLUTION LIABILITY,
Wisconsin Dept. of Justice, Madison. Public Intervenor Office.
T. J. Dawson.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 323-337.

Descriptors: *Wisconsin, *Groundwater pollution, *Liability, *Legal aspects, Civil law, Regulations, Solid wastes, Hazardous wastes.

The terms 'liability' and 'pollution' have to be defined initially to evaluate state programs for groundwater pollution in general and for that of Wisconsin in particular. To environmentalists, industry, pollution victims, and perhaps to a lesser extent, to regulators, liability is the risk or actuality of paying the costs of what has been termed 'groundwater pollution.' These costs are considered from the economic standpoint, although certain groundwater pollution consequences include noneconomic costs, such as physical and emotional injury for civil wrongs, and even imprisonment for criminal violations. Even these could be said to have economic value. However, this consideration of 'liability' for groundwater pollution in Wisconsin involves civil, criminal, and regulatory liability, such as the costs of complying with regulatory orders for cleanup and monitoring. Wisconsin's: (1) Solid Waste Laws; (2) Mining Laws; (3) Point Source Laws; (4) Groundwater Law; (5) Water Supply Damage Law; (6) Hazardous Substance Spills Law; and (6) 6-Citizen Complaint Statute, are all briefly presented. The rationale behind these laws and the impact of the liability provisions of the groundwater program are interpreted. (See also W89-02196) (Lantz-PTT)
W89-02217

COUNTY LEADERSHIP FOR GROUNDWATER CONCERNS,
Western Michigan Univ., Kalamazoo. Science for Citizens Center.
D. J. Brown.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 339-350, 2 fig, 5 tab, 6 ref.

Descriptors: *Public participation, *Groundwater quality, *Regulations, *Michigan, *Southwest Michigan Groundwater Survey and Monitoring Program, *County jurisdiction, *Water quality control, Data acquisition, Water quality, Education.

The originators of the Southwest Michigan Program saw the county as an appropriate and manageable sized governmental unit to address the problem of citizen access to government in connection with private or local water quality. The purpose of the Southwest Michigan Groundwater Survey and Monitoring Program is to safeguard the public health by using systematic methods to identify and protect the quality of groundwater in the region. Funded by a W.K. Kellogg Foundation grant, the Program operates a full-scale project in five counties and a more limited program in five additional counties. Program goals include the following: (1) establish a computerized geologic data base sufficient to identify and map the significant aquifers in the region; (2) establish a computerized water quality data base characterizing baseline or background water quality; (3) provide training in each member county to enable establishment and continuance of the data bases; (4) conduct an extensive program of chemical analysis of groundwater; (5) provide training in each member county to enable sanitarians to interpret and apply geological and water quality data to public health and water quality protection; (6) cooperate with all appropriate entities to produce a model system and program for state-wide and broader application; and (7) develop and execute a public education project focusing on groundwater and public health. (See also W89-02196) (Lantz-PTT)
W89-02218

INDUSTRY/AGENCY PERSPECTIVES ON STRATEGIES FOR PROTECTING GROUNDWATER,
National Agricultural Chemicals Association, Washington, DC.
T. J. Gilding, A. Beaujean, and J. A. Koski.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 379-391.

Descriptors: *Water pollution prevention, *Water pollution control, *Groundwater quality, *Regulations, *Water quality control, Groundwater management, Hazardous wastes, Fertilizers, Pesticides, Drinking water, Water supply.

The goal in groundwater protection and management is protection of groundwater quality for current or potential drinking water purposes or other uses which require a higher degree of protection. This goal can be met through: (1) moving away from commercial and industrial waste discharges into the groundwater; (2) preventing contamination at a potential source through reformulation of products, education and implementation of precautionary programs; and (3) timely permitting and vigorous monitoring activities. An effective monitoring program is necessary. The State of Michigan must move toward addressing issues and preventing groundwater pollution. By so doing, cleanup activities which have been enormously expensive will be minimized. The Groundwater Protection and Management Committee has made several recommendations which include: (1) The rules in Part 22 of Act 245 should be amended to define nondegradation and be promulgated by September, 1988; (2) The Water Resources Commission should develop a policy to implement the goal of moving away from commercial and industrial waste discharges into groundwater; (3) Steps should be taken to ultimately consolidate oversight responsibility for all groundwater protection and drinking water programs within one state agency; (4) A program should be developed to protect groundwater from leaking/inadequate storage and handling of petroleum and hazardous materials; (5) The State should provide funding for certified

local agencies for administering state standards for storage and handling of hazardous materials; (6) Administrative agencies should have the authority to impose administrative fines on chronic violators in order to improve groundwater protection enforcement, including drinking water supplies; (7) A consistent program for private well permitting should be instituted statewide; and (8) Local units of government with state technical assistance should be encouraged to consider groundwater management in planning and zoning as part of ongoing planning and zoning decisions. (See also W89-02196) (Lantz-PTT)
W89-02220

FEDERAL AND STATE ASSISTANCE FOR ACTION,
Geological Survey, Lansing, MI.
N. Grannemann, D. A. Smith, D. O'Neil, and C. E. Lietzau.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 393-398.

Descriptors: *Federal jurisdiction, *State jurisdiction, *Legal aspects, *Groundwater, *Michigan, *Water pollution control, *Water pollution prevention, Water quality control, Funding.

Assistance available from various federal, state and local government agencies in Michigan on problems associated with groundwater contamination or its protection is discussed. The U. S. Geological Survey program in Michigan is planned and funded cooperatively with 40 units of local government as well as state and federal agencies. The USGS publishes an annual series of reports titled 'Groundwater Data for Michigan ' which includes groundwater data collected for each calendar year. Additional studies are underway to relate land use to ground and surface water quality and quantity and to study pesticides in water. The U. S. Department of Agriculture, Soil Conservation Service conducts most of its work at the county level. Historically, the Soil Conservation Service has not had a role in groundwater resources but by controlling pollution on the surface, groundwater contamination problems may be reduced or eliminated. Assistance from the state of Michigan is available from various departments and agencies, such as the Department of Natural Resources, Groundwater Quality Division; the Department of Agriculture, Environmental Division; and the Department of Public Health. A wide range of technical expertise regarding all types of groundwater problems is available from the Groundwater Quality Control Section. (See also W89-02196) (Lantz-PTT)
W89-02221

6F. Nonstructural Alternatives

FLOOD PROOFING BIBLIOGRAPHY, ANNOTATED.
Soil Conservation Service, Washington, DC.
June 1988. 25p.

Descriptors: *Bibliographies, *Floodproofing, Floodplain management, Flood control, Flood protection.

One hundred and four references on various aspects of flood proofing are cited and annotated. The bibliography is for use by all Corps of Engineers and other interested persons requiring information on the subject, and includes topics which range from flood damage to costs, and case studies to shore protection and how homeowners can flood proof their homes. (Lantz-PTT)
W89-01807

WILD AND SCENIC RIVERS: CONSERVATION AND NATURAL WATER AMENITIES,
Ministry of Works and Development, Wellington (New Zealand).
C. J. Collins.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 59-74, 1 fig.

Descriptors: *Rivers, *Natural waters, *Environmental protection, *Instream flow, *Wild and scenic rivers, *Conservation, *Legislation, Water conservation, Lakes, Recreation.

Outlined is the status of in-stream values as they were under the original water and soil legislation and backgrounds why change was needed. Then discussed is the new protective measures, the water conservation order approach, provided by the 1981 amendment to the legislation; and the types of water-bodies that can be covered and the degree of protection afforded. The criteria to assess whether a particular river or lake should be protected, and to what extent, are investigated. Some implications of a water conservation order are explored. Finally a critique of the river conservation order approach to protecting in-stream values is offered and improvements suggested. (See also W89-01871) (Lantz-PTT)
W89-01877

6G. Ecologic Impact Of Water Development

EFFECTS OF THE DEVELOPMENT OF RURAL WATER SUPPLY ON THE GEOGRAPHIC RHYTHM OF THE VILLAGERS AND AGRICULTURE IN THE MTWARA REGION OF TANZANIA (MAASEUDUN VESIHUOLLON PARANEMISEN VAIKUTUS KYLALAISTEN MAANTIELEELLISEEN RYTMIIN JA MAANVILJELYYN MTWARAN LAANIN ALUEELLA TANSANIASSA),
Helsinki Univ. (Finland). Inst. of Development Studies.
For primary bibliographic entry see Field 3D.
W89-01312

EARTHQUAKES, INJECTION WELLS, AND THE PERRY NUCLEAR POWER PLANT, CLEVELAND, OHIO,
Ohio Univ., Athens. Dept. of Geological Sciences.
For primary bibliographic entry see Field 8E.
W89-01335

LESSONS FROM EIA FOR BICOL RIVER DEVELOPMENT IN PHILIPPINES,
Philippines Univ. at Los Banos. Coll. of Engineering and Agro-Industrial Tech.
R. Abracosa, and L. Ortolano.
Journal of Water Resources Planning and Management (ASCE) JWPED5, Vol. 114, No. 5, p 517-530, September 1988. 2 fig, 12 ref.

Descriptors: *Environmental impact statement, *Philippines, *Environmental policy, *Bicol River Basin, *Water resources development, Regional development, Rural areas, River basins, Planning, Performance evaluation.

Beginning in 1975, the Bicol River Basin Development Program (BRBDP) of the Philippines embarked on a plan to develop the Rinconada area by providing integrated projects for rural development. Environmental studies were done, but largely in response to procedural requirements of the U.S. Agency for International Development. The Philippine environmental impact statement requirements were not taken seriously. The resulting environmental assessment was inadequate and failed to predict negative impacts that followed project implementation, particularly construction of the Lake Buhi regulation project. The controversy caused by the adverse effects necessitated follow-on environmental studies and engineering works and enhanced the BRBDP's appreciation of environmental impact assessment as a practical planning tool. (Author's abstract)
W89-01367

DISEASE HAZARDS OF IRRIGATION SCHEMES,
Mahidol Univ., Bangkok (Thailand). Faculty of Tropical Medicine.
S. Sornmani, and C. Harinasuta.
World Health Forum WHFODN, Vol. 9, No. 2, p 254-257, 1988. 3 ref.

Descriptors: *Thailand, *Public health, *Human diseases, *Dam effects, Irrigation effects, Parasites, Mosquitoes, Malaria, Dengue ferer, Schistosomiasis, Liver flukes, Encephalitis, Dermatitis, Domestic animals, Opisthorchiasis, Snail, Fish.

The construction of river dams in north-east Thailand led to better navigational conditions, the generation of adequate amounts of electricity, improved water supplies for domestic and agricultural use, the expansion of fishing, and higher incomes. However, people in the area, particularly those where irrigation schemes were established, suffered increasing incidences of parasitic diseases, most notably opisthorchiasis. The construction of the dams resulted in changes in the fauna, some of which have had adverse effects on human health. There has been a rapid proliferation of mosquitoes that transmit malaria or dengue hemorrhagic fever, of certain snails and fish that spread liver-fluke infection, eosinophilic meningo-encephalitis, schistosomiasis, cercarial dermatitis, and gnathostomiasis, and of dogs, cats and rats, which serve as reservoirs for several pathogens. By involving the communities directly in a control program, it has proved possible to diminish this drawback to a significant extent. After three years, not only was opisthorchiasis under control but other aspects of primary health care had bee improved; thus better drinking-water supplies were available, toilet facilities were more widespread, and an essential drug program was established. (Author's abstract)
W89-01379

MACROBENTHIC COMMUNITIES FROM WETLAND IMPOUNDMENTS AND ADJACENT OPEN MARSH HABITATS IN SOUTH CAROLINA,
Marine Resources Research Inst., Charleston, SC.
For primary bibliographic entry see Field 2L.
W89-01425

FOOD HABITS AND DISTRIBUTION OF WINTERING CANVASBACKS, AYTHYA VALISINERIA, ON CHESAPEAKE BAY,
Patuxent Wildlife Research Center, Laurel, MD.
For primary bibliographic entry see Field 2L.
W89-01426

ENVIRONMENTAL CONTROLS OVER GEOTHERMAL ENERGY EXPLOITATION,
Melbourne Univ., Parkville (Australia). School of Law.
A. J. Bradbrook.
Environmental and Planning Law Journal, Vol. 4, No. 1, p 5-25, March 1987.

Descriptors: *Geothermal resources, *Resources development, *Environmental effects, *Legal aspects, *Aquifers, *Groundwater potential, Groundwater, Resources management, Australia, Groundwater pollution, Air pollution, Surface water, Water pollution.

The relationship between the environment, environmental law, and geothermal exploitation have so far received scant attention from either environmentalists or lawyers. What may be the environmental consequences of geothermal energy exploitation as well as how current environmental controls would apply to any such developments are explored. There are considerable geothermal resources in Australia, especially in Victoria. Recent research has shown that there are substantial aquifers containing warm to hot groundwater of good quality in the Otway and Gippsland Basins in southern Victoria. This groundwater is suitable for space heating and cooling. Atmospheric pollution, principally by sulfur dioxide, from geothermal steam exhaust, and surface water pollution resulting from geothermal exploration, are identified as major environmental problems. The relevance of existing legal controls to this resource is examined and legislative amendments which may be necessary to take account of the specific environmental problems posed by geothermal exploitation are suggested. Although the discussion concentrates primarily on the law of Victoria, since this is where any large-scale development of geothermal

resources seems likely to take place, it is nevertheless relevant to the whole of Australia, and possibly elsewhere, as a model for other states and countries to consider as and when geothermal exploration commences. (Author's abstract)
W89-01528

CHARACTERIZING THE INFLUENCE OF NATURAL VARIABLES DURING ENVIRONMENTAL IMPACT ANALYSIS,
Tennessee Valley Authority, Norris. Engineering Lab.
For primary bibliographic entry see Field 7A.
W89-01604

IN SITU CONTAMINANTS AND ENVIRONMENTAL ASSESSMENT: AN ECOLOGICAL SUMMARY,
FEARO, Halifax (Nova Scotia).
For primary bibliographic entry see Field 5C.
W89-01725

SOCIAL AND HUMAN RELEVANCE OF IN SITU SEDIMENTS,
Moncton Univ. (New Brunswick). Faculty of Social Sciences.
L. Desjardins.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 121-124, 9 ref.

Descriptors: *Social impact, *Water pollution, *Sediment contamination, Social participation, Social aspects, Information exchange, Environmental protection.

Pollution issues disturb the perfect harmony between human beings and nature, and between different human groups. The restoration of the harmony requires a revision of paradigms, values and the interactivity of systems. Ultimately, the choices will be made on the basis of very many concerns. The rational and the irrational will combine to form a series of remedial measures that may not satisfy the traditional view of progress nor the newly acquired vision of a restored environment. Any interaction between technocrats and decision-makers inevitably creates its own dynamics so that interacting becomes the mechanism by which one experiences and through which one's choices are molded by those of others. The interactivity process does not guarantee any particular solution, it only leads to the point where humans are now the focus of the exercise. (See also W89-01714) (Lantz-PTT)
W89-01726

ASSESSMENT OF SOCIO-ECONOMIC RAMIFICATIONS,
Waterloo Univ. (Ontario). Faculty of Environmental Studies.
For primary bibliographic entry see Field 6B.
W89-01727

PERCEPTIONS, PARADIGMS AND ETHICS: A PERSPECTIVE ON THE SOCIAL CONTEXT OF ENVIRONMENTAL ISSUES,
Department of the Environment, Ottawa (Ontario).
C. J. Starrs.
IN: Ecological Effects of In Situ Sediment Contaminants. Proceedings of an International Workshop held in Aberystwyth, Wales, 1984. Developments in Hydrobiology 39, Dr. W. Junk Publishers, Boston, 1987. p 131-135, 17 ref.

Descriptors: *Social aspects, *Environmental protection, *Canada, Public relations, Ecology, Social adjustment.

The rapid evolution in public perceptions and understandings of environmental issues in Canada has evolved to the point where today such issues are beginning to be seen as cultural issues. The array of environmental and other societal problems is bringing into question the taken-for-granted assumptions or the worldview of 'cultural paradigm' common to all industrialized countries. Many social analysts are suggesting that these problems are inherent in the industrial worldview and can therefore only be resolved by moving onward to another way of making sense of the world around us, and that elements of a new paradigm appear to be emerging. The major characteristics of the industrial worldview are described, and those of an emerging alternate worldview are sketched. Part of this societal questioning is evidenced in a resurgence of interest in environmental ethics but, except for 'deep ecology', this debate has yet to be linked to the broader discussion of shifting cultural paradigms. The changing social context suggests that there are opportunities to use different policy instruments than regulation that would prevent the occurrence of environmental damage in the first place. It also suggests that the active involvement of thoughtful and responsible citizens is essential if the current period of questioning is to lead to a society that is sound and dynamic in ecological and human terms. (See also W89-01714) (Author's abstract)
W89-01728

METHOD FOR TREATMENT OF DATA FROM THE INSTREAM FLOW INCREMENTAL METHODOLOGY FOR INSTREAM FLOW DETERMINATION,
Utah State Div. of Wildlife Resources, Salt Lake City.
For primary bibliographic entry see Field 4C.
W89-01737

STONEFLIES AND RIVER REGULATION - A REVIEW,
Oslo Univ. (Norway). Zoological Museum.
For primary bibliographic entry see Field 2H.
W89-01744

CLASSIFICATION OF TAILWATER SITES RECEIVING RESIDUAL FLOWS FROM UPLAND RESERVOIRS IN GREAT BRITAIN, USING MACROINVERTEBRATES DATA,
Freshwater Biological Association, Wareham (England). River Lab.
P. Armitage.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 131-144, 4 fig, 5 tab, 14 ref.

Descriptors: *Tailwater, *Flow regulation, *Macroinvertebrates, *Reservoirs, *Ecological effects, Great Britain, Reservoir operation, Fauna.

The amount of water left in rivers and streams after abstraction for public supply is referred to as the residual or compensation flow. In the past the quantities of water released from reservoirs have been the subject of arbitrary rulings. Throughout Great Britain there are a large number of reservoirs where decisions as to the amount of compensation flow to be released were made many years before the present archive of river flow data was available. Before guidelines for resetting reservoir operating policy and compensation releases can be prepared, it is important that information should be obtained on the biological consequences of particular compensation flows and in 1983 the macroinvertebrate fauna below 29 reservoirs was examined. This survey has revealed two interesting areas for future study: (1) the statistically significant but low correlation of faunal diversity with age of site; (2) the apparent 'aging' effect of reservoirs on some downstream sites provides evidence of the major disruption of continuum processes and this would repay a more detailed investigation. (See also W89-01736) (Lantz-PTT)
W89-01745

IMPACT OF LARGE DISCHARGE FLUCTUATIONS ON THE MACROINVERTEBRATE POPULATIONS DOWNSTREAM OF A DAM,
Lyon-1 Univ., Villeurbanne (France). Dept. de Biologie Animale et Ecologie.
O. Gaschinguard, and A. Berly.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 145-161, 8 fig, 1 tab, 26 ref, append.

Descriptors: *Fluctuations, *Ecological effects, *Macroinvertebrates, *Flow regulation, *Regulated flow, Rivers, Discharge, Benthic fauna, Stress, Species diversity.

The impacts of river regulation on downstream habitats have received frequent study, and good reviews have been given. The impacts of hydrodevelopments that include a reservoir are well known, however, little attention has been given to projects that lack a reservoir; situations in which only the flow rate has been modified. This paper deals with a comparison of the macroinvertebrate fauna in the up- and downstream sections of the Rhone River, close to Lyon (France), where only the flow rate has been modified. The presence of Jons Dam has modified the benthic habitat in the downstream section of the by-passed river through changes in hydraulic characteristics, sediments and organic matter content. These changes have accentuated the instability of the downstream environment. Abrupt hydraulic fluctuations in the by-passed section are responsible for the increased mobility of the substrate and increased hydraulic stress, which may cause the catastrophic drift of normally non-mobile invertebrates. Such an increase is particularly drastic for filter feeders and may cause the rarefaction of Hydropsychidae and bivalve mollusks. (See also W89-01736) (Lantz-PTT)
W89-01746

THERMAL 'RESETTING' OF STREAMS BY RESERVOIR RELEASES WITH SPECIAL REFERENCE TO EFFECTS ON SALMONID FISHES,
Freshwater Biological Association, Ambleside (England).
D. T. Crisp.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 163-182, 2 fig, 6 tab, 68 ref.

Descriptors: *Thermal pollution, *Reservoirs, *Fish, *Ecological effects, *Reservoir releases, *Flow regulation, Trout, Epilimnion, Seasonal variation.

A general review of effects of impoundments, including temperature effects, brief reviews of the thermal regimes in natural and regulated streams and a review of thermal regimes in rivers have been published in recent years. The nature and size of thermal changes associated with impoundment are variable and make it difficult to form any firm generalizations. This paper makes a brief general survey, illustrated with a small number of specific examples. This leads to an examination of the effects upon fish populations, with particular reference to salmonid fishes, especially the brown trout. During the period of stratification it would be possible to balance the output from epilimnic and hypolimnic draw-offs so as to attain any desired output temperature which fell between the temperatures of the epilimnion and the hypolimnion. In this way, the output temperatures could be brought close to those of natural tributaries. However, during the winter and early spring when reservoir water temperatures are relatively uniform throughout the depth range, this type of manipulation would not be possible and the effects of resetting the annual temperature cycle could not be entirely avoided. As has already been seen, temperatures during this particular period can have a large influence upon young stages of salmonid fishes. It would be possible, theoretically, to raise the temperature of winter releases by conserving heat in the reservoir by taking summer draw-off entirely from the hypolimnion. However, the amount of benefit obtained would need careful quantification for each individual reservoir and would have to be balanced against any harmful effects arising from low summer release temperatures. (See also W89-01736) (Lantz-PTT)
W89-01747

INSTREAM TEMPERATURE MODELING AND FISH IMPACT ASSESSMENT FOR A

PROPOSED LARGE SCALE ALASKA HYDRO-ELECTRIC PROJECT,
Alaska Univ., Anchorage. Marine Advisory Program.
W. J. Wilson, M. D. Kelly, and P. R. Meyer.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 183-206, 11 fig, 4 tab, 50 ref.

Descriptors: *Water temperature, *Hydroelectric plants, *Fish, *Ecological effects, Alaska, Thermal pollution, Model studies, Susitna River, Salmon.

The State of Alaska is proposing to construct a two dam, 1620 megawatt hydroelectric project (U.S. Federal Energy Regulatory Commission N. 7114) on the Susitna River approximately 190 km NNE of Anchorage. A study is underway to determine the effects this project may have on the indigenous aquatic resources of the Susitna drainage. Reported on here are the studies of the expected alteration of the instream temperature regime of the Susitna River. Twenty species of fish are known to inhabit the Susitna basin. This study focuses on the most numerous and economically valuable Pacific salmon species, approximately two million of which annually enter this river to spawn. Analysis of expected effects on salmon from altered water temperatures due to operation of the Susitna Hydroelectric Project is based on a comparison of available predictions from the Stream Network Temperature Simulation Model (SNTEMP) model with fish thermal tolerance criteria. Based on the SNTEMP model results, salmon thermal tolerance criteria, Susitna stock life history information, and professional judgement, the authors conclude that no direct mortality is anticipated to occur from with-project temperatures, athough unquantifiable, indirect mortality to some species may occur. (See also W89-01736) (Lantz-PTT)
W89-01748

HYDROPOWER DEVELOPMENT OF SALMON RIVERS: EFFECT OF CHANGES IN WATER TEMPERATURE ON GROWTH OF BROWN TROUT (SALMO TRUTTA) PRESMOLTS,
Direktoratet for Vilt og Ferskvannsfisk, Trondheim (Norway).
A. J. Jensen.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 207-218, 6 fig, 2 tab, 16 ref.

Descriptors: *Ecological effects, *Water temperature, *Trout, *Rivers, *Hydroelectric plants, Norway, Reservoirs, Model studies, Seasonal variation, Salmon, Fish.

Several salmon rivers in Norway have been regulated for hydroelectric purposes. Large reservoirs are often established in the mountains, and power plants discharge into salmon bearing parts of a river resulting in lower water temperatures in summer and higher water temperatures in winter. A model describing the growth rates of brown trout (Salmo trutta) at different temperatures when fed on maximum rations and on reduced rations has previously been constructed. This model has been tested on parr of eleven Norwegian sea trout populations in the present paper, based on these results the model has been adjusted to fit actual growth in these rivers. Hydropower regulation in the River Orkla, in central Norway was completed in 1983. The effect of regulation on river temperature has been predicted, and, based on these, the present growth model was used to predict the corresponding effect on growth of parr of the sea trout population. Both a high, stable flow in winter and a lower peak flow in spring is expected to improve nutrient conditions for fish. Higher winter temperature results in earlier eggs hatching than prior to regulation, hence, the growth season for fry will be prolonged. Both of these factors are responsible for a lower growth reduction than predicted from river temperature alone. Density of fish, and the competition between trout and Atlantic salmon may also change after regulation because of altered flow. Hence, the present method is not expected to illustrate the precise magnitude of growth change, but handles one of the most important of several parameters which influence growth. Possible changes in nutrient conditions or other factors must be considered separately. (See also W89-01736) (Lantz-PTT)
W89-01749

TIME-SCALES FOR ECOLOGICAL CHANGE IN REGULATED RIVERS,
Loughborough Univ. of Technology (England). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W89-01753

EFFECTS OF SHORT-TERM REGULATION BY POWER PLANTS ON EROSION AND WATER QUALITY OF A RIVER,
Valtion Teknillinen Tutkimuskeskus, Espoo (Finland).
E. Alasaarela, and M. Virtanen.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 277-287, 8 fig, 1 tab, 8 ref.

Descriptors: *Regulated flow, *Hydroelectric plants, *Erosion, *Rivers, Water quality, Turbidity, Flow velocity, Suspended solids, Ecological effects, Water resources development, Model studies.

Downstream of power plants with short-term regulation, the flow velocities are higher than in natural streams and there are large peaks of discharge during each day. This results in bank erosion which leads to variation of the suspended solids concentration and of turbidity. This and the erosion of the riverbed are the main disadvantages of short-term regulation. These problems are most obvious in summer. Since the economic significance of short-term regulation is most marked in winter, the need for summertime regulation should be considered separately in each case. The discharge of the diurnal quantity of water in several periods instead of one diminishes the erosion of the riverbed. As the erosion is most rapid during rising water level, the increase of suspended solids in the river water could be reduced by using lower rates of change of discharge. Moreover, the variations of water level can be reduced or shifted to suitable areas by means of bottom dams. Stone embankments and plantations can be used to prevent bank erosion. The effects of new projects can be predicted and their disadvantages minimized by means of the unsteady flow model and the model of sediment interaction controlled by short-term regulation. (See also W89-01736) (Lantz-PTT)
W89-01755

PHOSPHORUS SPIRALLING IN RIVERS AND RIVER-RESERVOIR SYSTEMS: IMPLICATIONS OF A MODEL,
Academy of Natural Sciences of Philadelphia, Avondale, PA. Stroud Water Research Center.
For primary bibliographic entry see Field 2H.
W89-01757

WATER TEMPERATURE CONTROL AND AREAL OXYGEN CONSUMFTION RATES AT A NEW RESERVOIR, AND THE EFFECTS ON THE RELEASE WATERS,
Army Engineer District, Portland, OR.
For primary bibliographic entry see Field 2H.
W89-01759

POSSIBLE EFFECTS OF THE PROPOSED EASTERN ROUTE DIVERSION OF CHANGJIANG (YANGTZE) RIVER WATER TO THE NORTHERN PROVINCES WITH EMPHASIS ON THE HYDROBIOLOGICAL ENVIRONMENT OF THE MAIN WATER BODIES ALONG THE TRANSFER ROUTE,
Academia Sinica, Lochiaschan (China). Inst. of Hydrobiology.
H. Wu.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 363-372, 3 fig, 2 tab, 7 ref.

Descriptors: *Changjiang River, *Diversion, *Ecological effects, *Rivers, Hydrological studies, Water resources development, China, Fish, Ecosystems, Foods, Spawning, Ecosystems.

In China there is an abundance of water in the south, the main sources being the Changjiang (Yangtze) River and its tributaries, while in the north, where the main supply is the Huanghe (Yellow) River, there is a shortage of water. The average annual rainfall throughout south China is more than 1000 mm while in the north it is only 500-600 mm. The Changjiang River Basin and areas to the south receive 75% of the country's total surface runoff, while the Huanghe Basin and areas to the northwest receive only 8%. The Changjiang River has an annual flow of close to 100 times 10 to the 10th power cu m/yr, while the Huanghe River which is almost the same length, has an annual flow of less than 5 times 10 to the 10th power cu m. This disparity in water distribution indicates the need for eventual transfer of water from south to north. The influx of diversion water into lakes will dilute existing nutrient concentrations and reduce water temperatures thereby resulting in a decrease in planktonic and mollusk biomass. Assuming a diversion flow rate of 800 cu m/sec, the flushing rate of the 253,000 ha Hongze Lake would be reduced to 55 days. As a result: (1) the food supply of herbivorous fish, such as grass carp, bream and filter feeders such as the silver carp and bighead, will be greatly reduced; (2) spawning conditions for fish that lay adhesive eggs on aquatic macrophytes will be adversely affected; (3) conditions for small pelagic fish will improve; and (4) the reduction of mollusk populations in several lakes would have serious consequences. (See also W89-01736) (Lantz-PTT)
W89-01761

CHEMICAL AND BIOLOGICAL CHANGES IN THE TER RIVER INDUCED BY A SERIES OF RESERVOIRS,
Barcelona Univ. (Spain). Dept. de Ecologia.
M. A. Puig, J. Armengol, G. Gonzalez, J. Penuelas, and S. Sabater.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 373-382, 8 fig, 4 tab, 10 ref.

Descriptors: *Water resources development, *Reservoirs, *Ter River, *Rivers, *Spain, *Ecological effects, Chemical properties, Biological properties, Nutrients, Phosphorus, Nitrogen, Macroinvertebrates.

The climatological and topographical characteristics of the Iberian peninsula have made the construction of reservoirs a necessity. Thus, more than 700 reservoirs have been constructed since the beginning of the century, one hundred of which have been the object of intensive study. The interaction between the effects produced by the pollution above the reservoirs (station 22) and the ecological discontinuities caused by the reservoirs themselves resulted in effects which balanced one another. This compensation was very clear in the case of nutrients, where more than 81% of the phosphorus and nitrogen entering the reservoirs was retained. This resulted in the occurrence of similar nutrient concentrations in both stations below the reservoirs and in unpolluted stations above the reservoirs. Distinct biological communities were observed above and below the reservoirs. This situation was facilitated by the presence of a dispersion barrier (i.e., the dam). In the River Ter, there was no observable decrease in macroinvertebrate diversity below the reservoirs. The authors believe that this was a result of the lack of thermal stress as well as the presence of high substrate diversity below the reservoirs. (See also W89-01736) (Lantz-PTT)
W89-01762

RESPONSES OF EPILITHIC ALGAE TO REGULATION OF ROCKY MOUNTAIN STREAMS,
Colorado State Univ., Fort Collins. Dept. of Botany and Plant Pathology.
R. G. Dufford, H. J. Zimmermann, L. D. Cline, and J. V. Ward.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 383-390, 2 fig, 3

tab, 28 ref.

Descriptors: *Algae, *Epilimnion, *Rocky Mountains, *Streams, *Ecological effects, *Regulated flow, Water temperature, Biomass, Eutrophication, Reservoirs, Nutrients, Turbidity.

The effects of deep-release reservoirs on the phytobenthos in this study are similar to those reported for other localities. Algal biomass was dramatically higher, filamentous green algae formed dense mats and eutrophic taxa became more prevalent in the flora below the impoundments. The flora of reference and regulated sites of the surface-release reservoirs were similar in species composition. However, the algal biomass was significantly higher at the regulated sites. The increase in algal biomass below the deep-release reservoirs was believed to be caused by increased nutrient loading as well as high water clarity, relatively stable flow and water temperatures which favor cold-stenotherms, yet prevent ice formation. (See also W89-01736) (Lantz-PTT)
W89-01763

ECOLOGY OF REGULATED STREAMS: PAST ACCOMPLISHMENTS AND DIRECTIONS FOR FUTURE RESEARCH,
Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
J. V. Ward, and J. A. Stanford.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 391-409, 3 fig, 1 tab, 86 ref.

Descriptors: *Ecological effects, *Regulated flow, *Streams, Dams, Reservoirs, Ecosystems, Stream flow.

The control of stream discharge by man made has been practiced for millennia, yet recognition of the often dramatic ecological changes in downstream lotic reaches has been slow. Until quite recently most research focused on the lentic water body behind the dam, despite the fact that virtually all of the world's river systems are regulated by dams. Reviews dealing with ecological effects of impoundment, although otherwise comprehensive, often give only cursory and general consideration to the receiving stream environment. The principal theme of this paper is that stream ecologists should strive toward a more holistic perspective of regulated streams should be integrated with stream ecosystem concepts and placed within the context of modern ecological theory. Regulated rivers are four-dimensional systems according to this viewpoint. The lateral dimension extends beyond the shoreline and considers the stream channel as but a part of the greater landscape. The longitudinal dimension extends from the headwaters to the estuary and marginal seas. Vertically the stream is viewed as an integral part of the groundwater system. The fourth dimension, time, provides the temporal framework. (See also W89-01736) (Lantz-PTT)
W89-01764

WILDLIFE PROTECTION, MITIGATION, AND ENHANCEMENT PLAN, PALISADES PROJECT,
Idaho Dept. of Fish and Game, Boise.
For primary bibliographic entry see Field 5G.
W89-01771

HOHOKAM SETTLEMENT ALONG THE SLOPES OF THE PICACHO MOUNTAINS. VOLUME 2, PART 1 - THE BRADY WASH SITES.
Museum of Northern Arizona Research Paper 35, Volume 2, Part 1, 1988. 424p, 53 fig, 115 tab, 18 plates, 98 ref. Bureau of Reclamation Contract 3-CS-30-00790.

Descriptors: *Archaeology, *Environmental impact, *Arizona, Aqueducts, Water resources development.

This volume (Part 1 of 2 parts) documents the excavation and testing by the Museum of Northern Arizona of 92 structures, a platform mound, and numerous other features at 15 loci of the Brady Wash site and six small sites in Reach 1 of the Tucson Aqueduct Project, Phase A. These sites are a major segment of the Brady Wash Complex, a Hohokam community that inhabited the floodplain below the northwest slopes of the Picacho Mountains. These investigations provide detailed insight into long-term Hohokam adaptation to a marginal, nonriverine environment. (See also W89-01782) (Author's abstract)
W89-01781

HOHOKAM SETTLEMENT ALONG THE SLOPES OF THE PICACHO MOUNTAINS. VOLUME 2, PART 2 - THE BRADY WASH SITES.
Museum of Northern Arizona Research Paper 35, Volume 2, Part 2, 1988. 476 p, 96 fig, 234 tab, 31 plates, 102 ref, 3 append. Bureau of Reclamation Contract 3-CS-30-00790.

Descriptors: *Archaeology, *Environmental impact, *Arizona, Aqueducts, Water resources development.

This volume (Part 2 of 2 parts) documents the excavation and testing by the Museum of Northern Arizona of 92 structures, a platform mound, and numerous other features at 15 loci of the Brady Wash site and six small sites in Reach 1 of the Tucson Aqueduct Project, Phase A. These sites are a major segment of the Brady Wash Complex, a Hohokam community that inhabited the floodplain below the northwest slopes of the Picacho Mountains. These investigations provide detailed insight into long-term Hohokam adaptation to a marginal, nonriverine environment. (See also W89-01781) (Author's abstract)
W89-01782

HOHOKAM SETTLEMENT ALONG THE SLOPES OF THE PICACHO MOUNTAINS. VOLUME 5: ENVIRONMENT AND SUBSISTENCE,
Museum of Northern Arizona, Inc., Flagstaff. Dept. of Anthropology.
D. E. Weaver, R. E. Gasser, and J. Gish.
Available from the National Technical Information Service, Springfield, VA. 22161. Museum of Northern Arizona Research Paper 35, Volume 5, 1988. 310p, 13 fig, 93 tab, 1 plate, 201 ref, append. Bureau of Reclamation Contract 3-CS-30-00790.

Descriptors: *Hohokam Indians, *Archaeology, *Water resources development, *Social aspects, *Environmental impact, Tucson aqueduct, History, Surveys.

This is the fifth volume in a six volume series presenting the results of archaeological studies at Hohokam sites along the Tucson Aqueduct. The volume focuses on pollen, flotation and faunal studies in an effort to understand the paleoenvironment of the study area during the periods the sites were occupied and the subsistence strategies of the sites' occupants. Primary site-specific emphasis is on determining feature functions as they relate to biological results. The studies presented document considerable variation in Hohokam subsistence patterns within a relatively small region. While the occupants of the Brady Wash area sites relied on corn and agave, the Hohokam in the Picacho area sites relied primarily on Cheno-ams, mesquite, agave and hunted wild animals. The summary statements on paleoenvironment and subsistence deal with methodological problems in an effort to suggest improvements in specialist studies in Hohokam archaeology. (Author's abstract)
W89-01803

WADDELL DAM, MARICOPA COUNTY, ARIZONA: PHOTOGRAPHS; WRITTEN HISTORICAL AND DESCRIPTIVE DATA, REDUCED COPIES OF DRAWINGS,
National Park Service, San Francisco, CA. Historic American Building Survey.
For primary bibliographic entry see Field 8A.
W89-01805

DETROIT RIVER, MICHIGAN: AN ECOLOGICAL PROFILE,
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
For primary bibliographic entry see Field 2H.
W89-01806

RECOMMENDED BIOLOGICAL INDICES FOR 301(H) MONITORING PROGRAMS,
Environmental Protection Agency, Washington, DC. Office of Marine and Estuarine Protection.
For primary bibliographic entry see Field 7B.
W89-01812

COMPUTER MODELS IN ENVIRONMENTAL PLANNING,
Ohio State Univ., Columbus. Dept. of City and Regional Planning.
For primary bibliographic entry see Field 6A.
W89-01823

AQUATIC BIOLOGY AND HYDROELECTRIC POWER DEVELOPMENT IN NEW ZEALAND.
Oxford University Press, New York. 1987. 280p. Edited by P. R. Henriques.

Descriptors: *Environmental effects, *Aquatic environment, *Water resources development, *Environmental impact, *New Zealand, *Hydroelectric Power, Powerplants, Legal aspects, Management planning, Wetlands, Ecosystems, Fish, Birds, Macrophytes, Invertebrates, Aquatic plant control.

This book attempts to summarize the current knowledge of hydroelectric power development as it relates to aquatic biology in New Zealand, in order to facilitate the design of environmental impact studies, and to further develop mitigating measures for those species already adversely affected by hydroelectric power development. In addition, it demonstrates the progress that has been made to date in predicting, assessing, and ameliorating problems related to aquatic biology and hydroelectric power development. The first section of the book describes the country's hydroelectric resources and their utilization. The second section discusses the legal and planning framework associated with hydroelectric power development and the environment, including the assessment of environment impact, water rights, the protection of wild and scenic rivers, and the activities of the Nature Conservation Council. The third section of the book deals with management techniques, including flow control, control of aquatic weeds, methods of improving fish populations, and of dealing with wetland birds. The final section discusses environmental investigations for future hydroelectric power development, especially the likely impact of future developments on phytoplankton, periphyton, aquatic macrophytes, invertebrates, fish and wetland birds. (See W89-01872 thru W89-01891) (Lantz-PTT)
W89-01871

STATE (LARGE-SCALE) HYDROELECTRIC RESOURCES,
Ministry of Works and Development, Wellington (New Zealand).
For primary bibliographic entry see Field 6A.
W89-01872

LOCAL (SMALL-SCALE) HYDROELECTRIC RESOURCES,
Ministry of Works and Development, Wellington (New Zealand).
For primary bibliographic entry see Field 6A.
W89-01873

ENVIRONMENTAL IMPACT ASSESSMENT,
Ministry of Works and Development, Wellington (New Zealand).
A. J. Voice.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 28-39, 2 fig, 1 tab, 12 ref.

Descriptors: *Water resources development, *Environmental effects, *New Zealand, *Environmental impact, Public participation, Public policy, Economic aspects, Social aspects, Case studies, Resources development, Community development.

Under the provisions of the Environmental Protection and Enhancement Procedures all new policies and projects are required to undergo environmental impact assessment if they are initiated, funded or come under the control or responsibility of a government department. The procedure used to assess and document the environmental impacts of a particular proposal depends on the expected significance of the impacts and the degree of public interest. The choice of procedure is made in the light of preliminary studies and consultation with interested parties. If environmental impacts or public concern are expected to be significant an Environmental Impact Report is usually required and this is independently reviewed by the Commission for the Environment. If impacts and public concern are expected to be slight then a less formal Environmental Impact Assessment document is prepared and reviewed by the responsible government department. An important aspect of environmental impact assessment is the involvement of the public. Ideally, public participation is not confined to making submissions on a document but entails the involvement of the affected community throughout the whore planning and implementation period. If a community is going to be seriously affected, an in-depth social impact assessment should be carried out. Social impact assessment 'is an attempt to predict the future effects of policy decisions (including the initiation of specific projects) upon people; their physical and psychological health, well-being and welfare, their traditions, lifestyles, institutions and inter-personal relationships'. The process of environmental impact assessment is intended to assist decision-makers to take into account all the advantages and disadvantages of their choices. A case study, the Patea Hydro-Scheme, New Zealand, is cited. The Patea hydro-scheme environmental impact assessment illustrates how the formal assessment procedures, if properly applied, can assist in project planning. The early and continuing release of information to the public allayed their concerns and encouraged their support. Environmental issues were identified and considered at an early stage, enabling modifications to be made to the scheme plan before construction began, thus saving time and expense in the long run. (See also W89-01871) (Lantz-PTT)
W89-01874

MEASURES TO BENEFIT WETLAND BIRDS,
Ministry of Agriculture and Fisheries, Dunedin (New Zealand).
For primary bibliographic entry see Field 2H.
W89-01885

PREDICTION OF PHYTOPLANKTON ABUNDANCE AND ITS EFFECT ON WATER QUALITY,
Ministry of Works and Development, Hamilton (New Zealand). Water Quality Centre.
For primary bibliographic entry see Field 2H.
W89-01886

PERIPHYTON,
Ministry of Works and Development, Christchurch (New Zealand). Hydrology Centre.
For primary bibliographic entry see Field 2H.
W89-01887

AQUATIC MACROPHYTES,
Ministry of Energy, Dunedin (New Zealand). Electricity Div.
P. R. Henriques.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 207-222, 2 fig, 1 tab, 40 ref.

Descriptors: *Macrophytes, *Aquatic environment, *New Zealand, *Ecological effects, *Aquatic plants, Environmental effects, Hydroelectric plants, Aquatic weeds, Conservation, Reservoirs.

Predicting the effect of hydroelectric power development on freshwater macrophytes is a relatively new discipline in New Zealand. While recognizing that macrophytes were ecologically significant, the first reports tended to emphasize the potential problems that noxious species pose when a river environment is turned into a hydroelectric reservoir (hydro-lake). More recent studies on the Lower Waitaki River, have expanded in scope to include also a consideration of whether rare macrophyte species or habitat will be affected. This chapter lists the beneficial aspects of the macrophytes, describes the nuisance value certain species pose, discusses aspects related to the conservation of macrophyte species and habitats, and finally presents three case studies to serve as examples of pre-impoundment macrophyte investigations carried out in New Zealand. (See also W89-01871) (Lantz-PTT)
W89-01888

INVERTEBRATES,
Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
M. J. Winterbourn.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 223-236, 2 tab, 61 ref.

Descriptors: *Invertebrates, *Ecological effects, *New Zealand, *Aquatic environment, *Reservoirs, *Aquatic animals, Hydroelectric plants, Environmental effects, Water resources development, Plankton, Benthic organisms, Rivers, Dams.

Impoundments bring about changes in water quality due to storage, they provide barriers to the migration of fish, and of particular interest to stream ecologists, they result in changes in flow regime. Biological studies associated with hydroelectric schemes in New Zealand have dealt principally with the phytoplankton and submerged macrophyte communities of the Waikato River system. The aim of this chapter is to outline the effects of river impoundment on the aquatic invertebrate fauna with particular reference to New Zealand. The planktonic, benthic and marginal zone communities of impoundments are discussed along with the benthos of regulated rivers below dams. (See also W89-01871) (Lantz-PTT)
W89-01889

WETLAND BIRDS,
Ministry of Agriculture and Fisheries, Christchurch (New Zealand).
For primary bibliographic entry see Field 2H.
W89-01891

SYSTEMS ECOLOGY AND ENVIRONMENTAL LAW: DO THEY SPEAK THE SAME LANGUAGE,
Envirosphere Co., Bellevue, WA.
For primary bibliographic entry see Field 6E.
W89-01895

PHENOMENOLOGICAL PERSPECTIVE OF ECOLOGICAL DEVELOPMENT,
Maryland Univ., Solomons. Chesapeake Biological Lab.
For primary bibliographic entry see Field 5C.
W89-01898

ENVIRONMENTAL CONDITIONS FOR WATER RESOURCES PROJECTS,
E. O. Gangstad, and C. G. Ash.
IN: Environmental Management of Water Projects. CRC Press, Inc., Boca Raton, FL. 1987. p 3-25, 5 fig, 18 ref.

Descriptors: *Environmental protection, *Legislation, *Water resources development, *National Environmental Policy Act, Water pollution control, Construction, Regulations.

National policy requires that federal agencies act to include in their construction projects measures to enhance and preserve the natural environment. Specification provisions controlling contractor activities have been effective in minimizing air, water, and noise problems associated with construction activities. Design and construction of structures of all kinds have incorporated measures which provide for environmental quality and protection. A guiding principle has been to incorporate aesthetics in terms of the general public. This chapter covers general reference to the National Environmental Policy Act of 1960 (NEPA) of the ways environmental quality is ensured by the Bureau of Reclamation and the Corps of Engineers. (See also W89-01990) (Author's abstract)
W89-01991

HISTORIC ROLE OF A LARGE LAKE IN JAPAN - THE CASE OF LAKE BIWA,
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
K. Tatuo.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 31-46, 11 fig, 1 tab.

Descriptors: *Social aspects, *History, *Archaeology, *Lake Biwa, *Japan, Navigation, Urban areas, Water resources development, Hydroelectric power, Water quality control, Regulations, Water management.

Lake Biwa is the only inland water body in Japan that deserves the name of a 'large lake' Located close to the oldest capitals and big cities such as Nara, Kyoto and Osaka, it has played a significant role throughout Japan's history. The main functions of rivers and lakes for pre-modern societies were to supply fishery products and serve as inland traffic routes. In a country like Japan where rivers are short and mostly torrential, lakes were particularly important as highways for boat transportation and traffic. With the urban growth of Kyoto more and more ports became available on the lake shores for trans-lake traffic. Starting in 1867 initiatives in civil engineering were taken by a pioneering attempt to utilize Lake Biwa's water resource. The potential value of Lake Biwa as a large water resource was recognized. At the request of the governor of Kyoto Prefecture, Tanabe-Sakuo designed and supervised the construction of a canal that conducts water from Lake Biwa to Kyoto city. The Lake Biwa Canal was completed in 1890. Originally, the canal was a multi-purpose canal. It was intended to serve as a source of water for domestic use, irrigation, replenishing urban streams for hydroelectric power generation and transportation by boats. A hydroelectric plant started operation in Kyoto in 1981. To cover increasing demand, a new water resource development project, called the Lake Biwa Comprehensive Development Project, was initiated in 1972. It is expected to continue until 1991. The objective is to increase the rate of lake water outflow at the Seta Barrage by 40 cu m/sec over the present rate. (See also W89-02176) (Lantz-PTT)
W89-02178

INDUSTRIAL SITING IN A DEVELOPING COUNTRY THE CASE OF ARGENTINA - ITS CONTEXT - THE ENVIRONMENTAL DIMENSION, HAZARDOUS WASTE AND LARGE LAKES,
Indiana Univ. at Bloomington.
P. Tarak.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 119-135, 24 ref.

Descriptors: *Industrial plants, *Developing nations, *Argentina, *Site selection, *Water pollution prevention, Case studies, Environmental protection.

The context within which an industrial siting process takes place in most developing countries is characterized by the lack of environmental legal constraints. Industrial siting becomes exclusively an administrative process where environmental as-

pects stay mostly under the discretional spheres of the officers in charge of the permit granting process. These officers are governed by the internal regulations of the Administration. Moreover, and very often, environmental concerns are neutralized by not only economic and social benefits of the projects, but also by behavioral patterns of societies and its bureaucracies that allow corruptive practices such as bribery, personal and political favoritisms and authoritarian threats to succeed. The different systems under which industrial siting can take place, the kind of policies that should be promoted to avoid imitating the developing world's political-historical evolution and the various mechanisms available which can be used to introduce direct public involvement during industrial siting processes are described. Finally, a case study is analyzed regarding the design of a new 'Technological Park' in the area of Lake Nahuel Huapi, Argentina. (See also W89-02176) (Lantz-PTT)
W89-02184

IMPACT OF LAKE CHANGSHOU ON THE ENVIRONMENT,
Chengdu Univ. of Science and Technology (China).
W. Zhao, and Z. Zhu.
IN: Toxic Contamination in Large Lakes. Volume IV: Prevention of Toxic Contamination in Large Lakes. Managing a Large Ecosystem for Sustainable Development. Lewis Publishers, Chelsea, Michigan, 1988. p 287-303, 1 tab.

Descriptors: *Ecological effects, *Water resources development, *Lake Changshou, *China, Fish, Irrigation, Water supply, Navigation, Public health, Waterfowl, Environmental effects, Social aspects.

Lake Changshou is a reservoir constructed in 1957 in Sichuan Province of the Longxi River, a tributary to the Changjiang (Yangtze). It has a surface area of 65 sq km and a volume of 1.027 billion cu m. The main goal in construction of the reservoir was electrical power generation (total capacity: 104.5 thousand kW). Construction of the reservoir also provided significant benefits to irrigation and navigation. Malarial incidence in the lake region has decreased since the reservoir was filled. Displacement of population and loss of arable land were the main problems encountered after lake construction. Changes in herbaceous and piscine life after filling are discussed in detail. Improvements in waterfowl population are briefly noted. Toxic contamination is not serious, and water quality in the lake is basically good. There is some tendency towards nitrogen eutrophication. Although studies performed after filling indicate that the effects of reservoir construction are beneficial, they also indicate that records for the period prior to construction are less complete than could be wished. For fuller quantification of benefits and environmental impact, it is suggested that more extensive investigations be carried out before dam construction. (See also W89-02176) (Author's abstract)
W89-02195

7. RESOURCES DATA

7A. Network Design

INSTALLATION OF HYDROCARBON DETECTION WELLS AND VOLUMETRIC CALCULATIONS WITHIN A CONFINED AQUIFER: A CASE STUDY,
Engineering Enterprises, Inc., Norman, OK.
M. L. Trimmell.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 255-269, 8 fig, 3 tab.

Descriptors: *Monitoring, *Confined aquifers, *Oil recovery, *Test wells, *Path of pollutants, *Pollutant identification, Boreholes, Oil spills, Hydrocarbons, Rotary drilling, Mathematical studies, Oil-water interfaces.

Two case studies involving the installation of hydrocarbon detection wells and related hydrocarbon volumetric calculations and considerations for confined aquifers are presented. The installation of hydrocarbon detection wells routinely requires attentive observations of return cuttings or core sampling from the associated boreholes. Confined conditions increase the importance of professional well logging procedures. Depending on the drilling method used, the depth at which floating hydrocarbons are encountered can be quite difficult to determine. Rotary drilling does not provide an immediate opportunity to measure the confining aquifer pressure. The drilling fluid used, normally displaces any confined hydrocarbons that would otherwise tend to rise following penetration of the confining layer. Subsequent well development removes any fluid volumes introduced during drilling and will then allow measurement of the hydrocarbon and water levels from which the potentiometric surface can be determined. Once the confining layer is penetrated using a hollow-stem auger, the hydrostatic head immediately forces the floating hydrocarbons upward within the borehole. The potentiometric fluid elevation can then be determined after correcting for the measured thickness of hydrocarbons on the water surface. There are different considerations which have to be given to volumetric calculations when investigating a confined aquifer. Under confined conditions, there is not a capillary fringe to correct for, but there is a hydrostatic head to consider. Once the confining layer is penetrated during drilling, the confining pressure forces fluid upward within the borehole. The hydrocarbons, having a lower density, quickly rise within the borehole. Thus, the measured thickness of hydrocarbons in the borehole is mostly a function of the hydrostatic head and not the actual thickness for the zone of saturation. A case study is presented that explains the necessary corrections. (See also W89-01530) (Author's abstract)
W89-01545

GROUND WATER MONITORING EXPERIENCE AT A REFINERY LAND TREATMENT UNIT,
Total Petroleum, Inc., Ardmore, OK.
P. E. Binkley.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 271-278, 4 fig, 1 tab, 1 ref.

Descriptors: *Test wells, *Groundwater pollution, *Geohydrology, *Monitoring, *Oil spills, Permits, Path of pollutants, Water pollution prevention, Water pollution control, Drilling, Oklahoma, Land disposal.

Total Petroleum, Inc. operates a land treatment unit at its Ardmore, Oklahoma, refinery for disposal of API separator sludge and slop oil emulsion solids. During the Part B permit application investigation, it became apparent that the geohydrology as described in the Part A submission was incorrect. The complete geohydrology was not defined at the submission of the Part B permit application. After permit review by Oklahoma State Department of Health (OSDH), Total initiated a detailed drilling program to obtain core samples to adequately describe the geohydrology. Cores were drilled to 150 feet on two sides of the site. The geohydrology was found to be very complex. There are five formations under the site dipping to the Northeast and striking to the Southeast. To adequately monitor the site, Total installed wells in four of the formations. There are four background wells and eleven downgradient wells. Total was asked to install Teflon or stainless steel wells as stated in the TEGD. A compromise was reached with OSDH and two Teflon wells were installed next to two PVC wells to prove the suitability of PVC wells. Since a new monitoring system was installed, Total had to re-establish the first year's four quarters of background data, but in six months. To carry all of the equipment needed to sample fifteen wells with dedicated bailers a trailer was built. Use of the trailer has made the sample round easier. (See also W89-01530) (Author's abstract)
W89-01546

DETECTION AND DELINEATION OF A FUEL OIL PLUME IN A LAYERED BEDROCK DEPOSIT,
TRC Environmental Consultants, Inc., Englewood, CO.
D. J. Folkes, M. S. Bergman, and W. E. Herst.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 279-304, 12 fig, 2 tab, 7 ref.

Descriptors: *Groundwater pollution, *Plumes, *Oily water, *Bedrock, *Path of pollutants, Hydrocarbons, Geohydrology, Boreholes, Colorado.

An investigation is being conducted of a fuel oil plume in south-central Colorado. The fuel oil plume is in thinly bedded claystone, siltstone and sandstone of the Pierre Shale Formation. The highly anisotropic properties of the bedrock affect vertical and horizontal distribution of the free product plume, and the techniques required for timely detection and delineation of the plume. Product was not detected in wells installed in the plume for several days, although up to 1.5 ft. of product was eventually measured in the wells. Perched product zones in the layered claystone may account for the well behavior. Because of slow product appearance in wells, hydrocarbon vapor analyses were found to be the most expedient method of plume detection and delineation. However, because of the low vertical permeability of the claystone, boreholes within 2 ft. vertically of the product zone did not allow detection of hydrocarbon vapors which were as high as 1500 ppm (measured as propane) in the vapor phase of the product zone. In contrast, vapors diffused readily in the horizontal direction, allowing contouring of the vapor concentrations and approximate delineation of the plume. The anisotropic permeability of the claystone deposit and bedrock structure appears to result in other phenomena which affect plume migration and detection, including exaggerated product thicknesses in wells, variable plume width and thickness, and sinuous migration pathways. (See also W89-01530) (Author's abstract)
W89-01547

AQUATIC MONITORING: A RATIONALE FOR OBTAINING AND INTERPRETING AQUATIC ECOSYSTEM CHEMICAL EXPOSURE DATA,
Monsanto Co., St. Louis, MO.
W. J. Adams, T. J. Hoogheem, and P. R. Michael.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 3-21, 2 fig, 8 tab, 36 ref.

Descriptors: *Network design, *Sampling, *Toxicity, *Monitoring, *Ecological effects, *Industrial wastes, Aquatic animals, Lake sediments, Fluvial sediments, Project planning, Trout, Daphnia, Crustaceans, Fathead minnows, Data interpretation.

Experience obtained through three years of national aquatic monitoring indicates that chemical monitoring programs need to include the following basic components: (1) a rationale for site selection; (2) a logical set of criteria for selection of sample types - that is, water, sediment or biota - based upon the physical-chemical and toxicological properties of the chemical of interest; (3) an appropriate cost-effective statistical design; (4) a team with a demonstrated capability for obtaining uncontaminated samples; (5) a top-notch analytical laboratory with experienced personnel, appropriate instrumentation, and fully validated and tested methods; (6) exacting quality-assurance and quality-control measures in all aspects of the program, including sample collection sample storage, and analyte determination; (7) an analytical limit of detection for environmental samples low enough to provide meaningful comparisons of biological effects and environmental exposure data; and (8) the capability to assess the monitoring data consistent with state-of-the-art aquatic hazard assessment techniques.

Using the above-mentioned components of an aquatic monitoring program, cumylphenyl diphenyl phosphate (CPDPP), a component of an industrial hydraulic fluid, was monitored in 1982 at 24 sites located across the continental United States. Assessment of the hazard of CPDPP for sites where detectable levels were observed was performed by calculating the margin of safety between environmental water concentration and acute and chronic toxicological effects for aquatic organisms inhabiting the water column and sediments. A new approach for assessing chemical concentrations on sediment is proposed. The technique consists of calculating sediment interstitial water concentration of CPDPP and comparing these values with toxicological effect concentrations observed in the laboratory for sediment-dwelling organisms. Concentrations of CPDPP in the environment ranged from <0.1 to 0.2 micrograms/L in surface water and from <100 to 200 micrograms/kg in sediment. CPDPP safety margins were a factor of 10 or greater for the most sensitive water column organism (lake trout) and 390 or greater for a typical sediment dwelling organism. (See also W89-01599) (Author's abstract)
W89-01600

RATIONALE FOR DATA COLLECTION AND INTERPRETATION IN THE NORTHERN LAKES LONG-TERM ECOLOGICAL RESEARCH PROGRAM,
Wisconsin Univ.-Madison. Center for Limnology.
T. K. Kratz, J. J. Magnuson, C. B. Bowser, and T. M. Frost.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 22-33, 2 fig, 2 tab, 8 ref. NSF Grant No. DEB 8012323.

Descriptors: *Data acquisition, *Eutrophication, *Data interpretation, *Lakes, *Water pollution effects, *Acid rain effects, Crayfish, Fish, Lake sediments, Wisconsin, Monitoring, Nutrients, Hydrogen ion concentration, Alkalinity, Cations, Anions, Plankton, Physical properties, Environmental impact statement, Light penetration, Heat budget.

The Northern Lakes Long-Term Ecological Research Program has three general goals: (1) to detect long-term changes in physical, chemical, and biotic features of lakes, (2) to understand linkages among water and sediment chemistry, hydrology, climate, and biology, and (3) to detect lake features associated with stability and resilience to natural and human disturbance. Eight northern Wisconsin lakes were selected for semi-intensive study. These lakes lie in the same local groundwater flow system and include oligotrophic, mesotrophic, and dystrophic types. To meet the first goal, an ongoing sampling program was established to provide seasonal or annual estimates of nutrients, pH, alkalinity, and major cations and anions), and biotic (including phytoplankton, zooplankton, macroinvertebrates, and fish) parameters. Frequency and timing of measurements are designed to allow comparisons among lakes, seasons, or years. In addition, long-term comparisons were made of recent data and those collected from the same lakes by Birge and Juday in the 1930's. To accomplish the second goal a series of shorter term, process-oriented studies have been instituted that are designed to describe mechanisms of interaction among system parts and to help refine sampling protocol. To meet the third goal, a whole-lake acidification experiment is being conducted along with ecological studies of invading fish and crayfish. (See also W89-01599) (Author's abstract)
W89-01601

SAMPLING EFFORT REQUIRED TO FIND RARE SPECIES OF FRESHWATER MUSSELS,
Michigan Univ.-Dearborn.
W. P. Kovalak, S. D. Dennis, and J. M. Bates.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 34-45, 4 fig, 4 tab, 5 ref.

Descriptors: *Mussels, *Population density, *Sampling, Lakes, Quantitative analysis, Mathematical studies, Mollusks, Clams, Cost analysis, Endangered species, Evaluation.

Several approaches for determining the sampling effort required to find rare species of freshwater mussels were examined. Methods based on the relationship between number of species and number of individuals collected may provide a basis for estimating sampling effort, but more research is required to verify their applicability. Collections of dead shells (from lake shores or river banks) cannot be used because dead shells do not accumulate in proportion to the occurrence of live specimens in adjacent waters. Methods based on quantitative sampling are most promising. However, several methodological problems must be overcome to make quantitative sampling cost-effective. A tentative protocol for searching for rare species is presented. A preliminary survey using qualitative methods is used to determine the distribution of mussels in a habitat. These data are used to stratify the habitat for quantitative sampling, preferably using quadrats. The number of samples taken depends on the scope of the study. Sample number may be set by some predetermined target density that must be detected or by funding. (See also W89-01599) (Author's abstract)
W89-01602

RATIONALE AND SAMPLING DESIGNS FOR FRESHWATER MUSSELS UNIONIDAE IN STREAMS, LARGE RIVERS, IMPOUNDMENTS, AND LAKES,
Tennessee Valley Authority, Muscle Shoals, AL. Div. of Air and Water Resources.
B. G. Isom, and C. Gooch.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 46-59, 1 fig, 9 tab, 23 ref.

Descriptors: *Mussels, *Sampling, *Population density, Tennessee, Quantitative analysis, Mollusks, Crustaceans, Lakes, Water pollution effects, Reservoirs, Rivers, Scuba diving.

Historically, the rationale for sampling freshwater mussels was almost entirely for purposes of taxonomy, natural history surveys, and conservation and propagation efforts following a decline of the pearl button industry in the early 1900s. The concept of quantitative sampling of freshwater mussels is almost unknown in historical literature. Except for some proprietary or unpublished quantitative studies, the first study designed primarily to quantitatively sample freshwater mussels was by Scruggs followed by Isom, Bates, and Isom, and Dennis and Bates. An earlier concept paper on quantitative sampling of mollusks and crustaceans can be found in Wurtz. Quantitative sampling methods for freshwater mussels within the context of varied study objectives, for example water pollution surveys are described. An example of a quantitative site-specific mussel study on the Cumberland River, Tennessee, is included. Difficulties with this study's design and application are discussed in some detail, along with site-specific studies on Kentucky Reservoir, Tennessee River, and Clinch River, Tennessee. (See also W89-01599) (Author's abstract)
W89-01603

CHARACTERIZING THE INFLUENCE OF NATURAL VARIABLES DURING ENVIRONMENTAL IMPACT ANALYSIS,
Tennessee Valley Authority, Norris. Engineering Lab.
R. T. Brown, and D. L. Dycus.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 60-75, 9 fig, 2 tab, 13 ref.

Descriptors: *Sampling, *Data interpretation, *Environmental impact, Temporal distribution, Physicochemical properties, Spatial distribution, Ecological effects, Environmental effects.

Biological field sampling can be expensive, time consuming, and highly variable in results. A major goal of ecological data collection should be to obtain maximum information from each series of biological samples. Major factors regulating sampled populations must be identified if impacts are to be discriminated from effects of natural environmental variations. There are often meteorological, hydrological, and water quality (physical- chemical) data available from nearby locations which can be used to describe the aquatic conditions between sample dates. A methodology for using environmental data to understand changes in biological populations better by characterizing variations in natural factors is described. Environmental factors which influence sampled organisms were examined to determine naturally occurring spatial gradients throughout the study region and temporal changes during the period of study. These environmental data were used to examine observed differences in sampled populations relative to natural environmental fluctuations. The methodology is demonstrated with environmental data used in the interpretation of phytoplankton samples. Recommendations are made for improving ecological data collection programs to allow analyses of impacts relative to natural environmental variations. (See also W89-01599) (Author's abstract)
W89-01604

CONCEPTUAL FRAMEWORK TO GUIDE AQUATIC MONITORING PROGRAM DESIGN FOR THERMAL ELECTRIC POWER PLANTS,
Washington Univ., Seattle. Dept. of Civil Engineering.
R. R. Horner, J. S. Richey, and G. L. Thomas.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 86-100, 1 fig, 20 ref.

Descriptors: *Model studies, *Electric powerplants, *Design criteria, *Monitoring, *Environmental impact, Computer models, Algorithms, Mathematical models, Project planning, Ecosystems, Cooling water, Entrainment, Water quality.

Thermal electric generating stations have a potential to alter the biotic and abiotic conditions in adjacent water bodies. Federal regulations require electrical utilities to monitor for such changes as insurance against deterioration of aquatic ecosystems. The cost of many monitoring efforts could be reduced by more precise applications of the scientific method (hypothesis testing), improved statistical design, and a focus on measures of cost-effectiveness. A multidisciplinary team of scientists and engineers from the University of Washington has developed such a conceptual framework to guide the design of power plant aquatic monitoring programs. This framework is organized into four hierarchical levels to accommodate the quality of information in a user's possession. Algorithms within the hierarchy help the monitoring program designer identify and prioritize mechanisms likely to cause ecological change, ecosystem components that might demonstrate a response, hypotheses of impact, and an appropriate sampling design for hypothesis testing. The entire framework has been programmed for interactive computer application. (See also W89-01599) (Author's abstract)
W89-01606

LEAF PROCESSING IN A RESERVOIR: AN EXPERIMENTAL APPROACH,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
A. C. Hendricks.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 150-156, 3 fig, 1 tab, 5 ref.

Descriptors: *Litter, *Leaves, *Food chains, *Field tests, Fish, Predation, Ecology, Reservoirs, Invertebrates, Sunfish, Virginia.

Group 7A—Network Design

The classical laboratory design of an experiment involves the utilization of a proper control and establishing various test treatments while holding conditions as close to those of the control as possible. In field work an experimental design such as that used in the laboratory is impossible to generate; however, field experimental work can be performed by controlling one parameter at a time and allowing this to serve as a treatment. The control in this case attempts to emulate the ecological system as close as possible. An experimental approach was utilized to determine how leaves were processed in a reservoir. Maple (Acer Spp.) leaf packets were placed in the reservoir utilizing the following experimental design: (1) Packets were placed in plastic trays and left open. These served as the controls. (2) Packets were placed in enclosures so that fish and other larger animals might not have access to the leaves. (3) Packets were placed in enclosures and a bluegill sunfish (Lepomis macrochirus) was added to each enclosure. Results from the experiments showed no significant differences between the leaf processing in the enclosure with and without fish. However, there were significant differences in leaf processing between open and enclosed leaf packets. At one time it took less than a month for this difference to occur, at another time it took from two to three months. (See also W89-01599) (Author's abstract)
W89-01609

DEVELOPING A SAMPLING STRATEGY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
J. Cairns, and J. R. Pratt.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 168-186, 3 fig, 2 tab, 67 ref.

Descriptors: *Sampling, *Hydrologic data collections, *Data acquisition, *Ecology, Ecosystems, Field tests, Water pollution effects, Project planning, Data interpretation, Test procedures, Species diversity, Statistical methods.

Sampling decisions must emphasize not only data collection and analysis, but also data use in decisions made for protection and management of aquatic ecosystems. Although data gathering is often the main focus of an investigation, it only provides the opportunity for generating information. The quality of this information is dependent upon the method of data acquisition and analysis, and the effectiveness of the decision made depends on the entire process - not only sampling. The basic problem with analyzing aquatic ecosystems is their complexity which may not be adequately displayed if the sampling program is not carefully designed. Furthermore, even the most effectively designed program may not achieve the desired objectives if the sampling program design does not recognize the way the information will be used. The limitation of common experimental designs and sampling methods including the use of structural and functional measures, the sampling of natural and artificial substrates, and use of appropriate statistical tests is discussed. Certain sampling regimes, including sampling over a single annual cycle, may underestimate ecosystem variability. The use of artificial substrates for collections may be misleading if the behavior of the substrate over time is not understood. Nevertheless, artificial substrates may show greater replicability and reliability than collections from naturally heterogeneous substrates. Generators of information should understand the uses that will be made of the data and that the limitations of the data should be understood by those who must make decisions with it. A simple checklist is provided for use of investigators to ensure adequate preparation of hypotheses, selection of sampling methods, and use of statistical tests. (See also W89-01599) (Author's abstract)
W89-01611

DEVELOPING GUIDES FOR SAMPLING AND ANALYSIS OF GROUND WATER,
Dow Chemical Co., Baton Rouge, LA. Louisiana Div.
L. I. Bone.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 337-342, 1 tab.

Descriptors: *Water quality, *Standards, *Water analysis, *Groundwater pollution, *Sampling, *Data acquisition, Pumps, Organic wastes, Vadose water, Monitoring, Water pollution prevention, Flushing, American Society for Testing and Materials.

American Society for Testing and Materials Committee D-34 on Waste Disposal has two subcommittees that are concerned with groundwater sampling: D34-02-08 on Groundwater Analysis and D34-01-01 on Environmental Monitoring and Sampling. Subcommittee D34-02-08 has been reviewing the Environmental Protection Agency's (EPA) Proposed SW 846 Method 8600 for screening groundwater for Appendix VIII compounds. Subcommittee D34-01-01 has prepared Guides for Sampling Ground Water Monitoring Wells and Pore Water Sampling in the Vadose Zone. The groundwater guide discusses flushing requirements, well sampling devices, and sample container and preservation requirements. Some of the guide's discussion concerning the advantages and disadvantages of sampling procedures and devices are presented and some recommendations based on the author's own experience are offered. Flushing 5 to 10 well volumes or until some parameter, such as pH or conductivity is stabilized, is recommended. Bailers, bladder pumps, or gas driven piston pumps are recommended, and the importance of preplanning sampling operations is emphasized. (See also W89-01634) (Author's abstract)
W89-01653

PRACTICES FOR SAMPLING SOLID WASTES FROM POINT DISCHARGES AND IMPOUNDMENTS,
Radian Corp., Austin, TX.
L. Holcombe, D. Johnson, and D. Lorenzen.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 353-366, 4 fig, 2 tab, 6 ref.

Descriptors: *Standards, *Sampling, *Waste characteristics, *Chemical analysis, *Data acquisition, Design criteria, Monitoring, Spatial distribution, Statistical methods, Data interpretation, Waste disposal, Solid wastes, American Society for Testing and Material.

Practices for sampling solid wastes from point discharges and impoundments are being developed for American Society for Testing and Materials Committee D-34 on Waste Disposal and will provide guidance for obtaining representative samples of solid wastes from point discharges and surface impoundments. The sampling guidelines outline safety procedures, design considerations, sampling equipment, and sampling procedures. Proper design is a key component of any waste sampling program and is emphasized in these practices. The frequency of sampling or the spatial distribution of samples required to obtain a descriptive sample depends on the variability of the waste composition and the precision of waste analysis required. Given the waste variability and precision requirements, the number of samples necessary can be calculated using fundamental statistical concepts. (See also W89-01634) (Author's abstract)
W89-01655

SOIL VAPOR MONITORING AS A COST-EFFECTIVE METHOD OF ASSESSING GROUND WATER DEGRADATION FROM VOLATILE CHLORINATED HYDROCARBONS IN AN ALLUVIAL ENVIRONMENT,
Kleinfelder (J.H.) and Associates, Walnut Creek, CA.
For primary bibliographic entry see Field 5A.
W89-01675

CAN BIOLOGICAL MONITORING EARLY WARNING SYSTEMS BE USEFUL IN DETECTING TOXIC MATERIALS IN WATER,
Army Medical Bioengineering Research and Development Lab., Fort Detrick, MD. Health Effects Research Div.
For primary bibliographic entry see Field 5A.
W89-01901

BIOLOGICAL IMPLICATIONS OF THE MANAGEMENT OF WASTE MATERIALS: THE IMPORTANCE OF INTEGRATING MEASURES OF EXPOSURE, UPTAKE, AND EFFECTS,
National Ocean Service, Seattle, WA. Ocean Assessments Div.
A. J. Mearns.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 335-343, 1 fig, 17 ref.

Descriptors: *Water pollution effects, *Waste management, *Ecological effects, *Toxicology, *Monitoring, *Management planning, *Aquatic toxicology, Bioaccumulation.

Mental tools are needed to remind us of the ultimate uses of aquatic toxicology research. These tools can aid those who manage conplex waste materials. A simple conceptual diagram is offered to remind researchers and managers of the need to simultaneously or sequentially acquire, or otherwise integrate, information on exposure, bioconcentration, and effects. The author urges researchers to weigh the benefits and statistical costs of acquiring these data in a multidisciplinary approach. (See also W89-01930) (Author's abstract)
W89-01951

7B. Data Acquisition

RECOMMENDATIONS FOR THE DETERMINATION OF PH IN SEA WATER AND ESTUARINE WATERS,
Newcastle upon Tyne Univ. (England). Dept. of Physical Chemistry.
A. K. Covington, and M. Whitfield.
Pure and Applied Chemistry PACHAS, Vol. 60, No. 6, p 865-870, June 1988. 14 ref.

Descriptors: *Water analysis, *Chemical analysis, *Standards, *Hydrogen ion concentration, *Seawater, *Estuarine water, Errors, Temperature, Salinity.

The International Union of Pure and Applied Chemistry (IUPAC) Commission on Electroanalytical Chemistry presents its recommendations for the determination of pH in sea water and estuarine waters. If a precision of + or - 0.01 in pH is required, it is recommended that: (1) The sample is at a constant, controlled temperature. (2) Electrode pairs should be standardized on either the pH(IUPAC) or pH(SWS) scales but the commercial availability of standard reference materials for the former makes this more convenient in practice for the time being. (3) The electrode pair should be characterized over the appropriate salinity and temperature range to assess the systematic errors associated with variations of liquid junction potential and hydrogen ion activity coefficient. This requires the determination of fH' and delta-pH values as appropriate, and the conversion factors should be published along with the measured pH(X) or pH(SWS) values. (4) Considerable advantages ensue from using a reference electrode design with renewable liquid junction such as the Culberson cell. By this means a precision of + or - 0.01 in pH is obtainable on a routine basis and standardization is only necessary at the beginning and end of a working day. (Author's abstract)
W89-01295

RECOMMENDED APPROACH TO THE EVALUATION OF THE ENVIRONMENTAL BEHAVIOR OF PESTICIDES: IUPAC REPORTS ON PESTICIDES, NO. 24,
CIBA-GEIGY A.G., Basel (Switzerland). Agricultural Div.

For primary bibliographic entry see Field 5A.
W89-01296

USE OF PLASTIC STRIPS TO MEASURE LEAF RETENTION BY RIPARIAN VEGETATION IN A COASTAL OREGON STREAM,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
R. W. Speaker, K. J. Luchessa, J. F. Franklin, and S. V. Gregory.
American Midland Naturalist AMNAAF, Vol. 120, No. 1, p 22-31, July 1988. 3 fig, 3 tab, 13 ref. National Science Foundation Grants DEB 80-12162, BSR 8514325, BSR 8112455-02 and BSR 8508356.

Descriptors: *Data acquisition, *Leaves, *Leaf retention, *Riparian vegetation, Shrubs, Streams, Particulate matter, Oregon.

The feasibility of using strips of plastic instead of leaves for estimating the rate of retention of coarse particulate organic matter (CPOM; >1 mm diameter) in streams was tested by simultaneously measuring retention of leaves and strips of plastic cut to approximately the same size as the leaves in six 3rd- and 4th-order streams. There was no significant difference in the retention rates between the two methods when all six study reaches were considered together, nor was there a difference in the location of retention of leaves and strips of plastic within a reach. However, the retention rate of plastic strips was significantly higher than that of leaves in the two reaches with the highest flows. Plastic strips were used to assess the importance of shrubby riparian vegetation in retaining CPOM in a 3rd-order stream. The density of streamside shrubs was reduced to approximately 60% and 0% of naturally occurring levels, and retention was measured by releasing known quantities of plastic strips into the stream. Retention was highest in the reaches where shrub densities were not reduced, intermediate in reaches that were thinned, and lowest in reaches where shrubs had been completely removed. Riparian vegetation was directly or indirectly responsible for 68% of the retention in the cleared reaches, 79% of the retention in the thinned sections and 84% of the retention in the control reaches. (Author's abstract)
W89-01332

PRACTICAL EXPERIENCE OF BOREHOLE PERFORMANCE EVALUATION,
For primary bibliographic entry see Field 5F.
W89-01356

DETERMINATION OF TWENTY-ONE CHLOROANISOLES IN WATER AND SEDIMENT SAMPLES,
National Water Research Inst., Burlington (Ontario). Research and Applications Branch.
For primary bibliographic entry see Field 5A.
W89-01377

FORCED-GRADIENT TRACER TESTS AND INFERRED HYDRAULIC CONDUCTIVITY DISTRIBUTIONS AT THE MOBILE SITE,
Auburn Univ., AL. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-01402

SIMULATION AND PARAMETER IDENTIFICATION OF MASS TRANSPORT IN GROUND WATER,
Bergakademie Freiberg (German D.R.).
For primary bibliographic entry see Field 2F.
W89-01409

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART IV,
K. Bedford, A. Findikakis, B. E. Larock, W. Rodi, and R. L. Street.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 114, No. 9, p 1034- 1051, September 1988. 3 tab.

Descriptors: *Turbulent flow, *Model studies, *Surface water, *Computers programs, *Hydraulic models, *Model testing, Automation, Fortran, Advection, Differential equations, Remote sensing.

The computer, numerical, and personnel requirements for turbulence model based surface water codes are discussed and suggested evaluation procedures for turbulence models are described. Hardware resources typically require substantial computing resources particularly for the case of time varying calculations. For the case of 3D flows, the solution of extra equations for turbulence quantities will not add much extra time to the calculation. Codes may be developed or acquired with acquisition of public domain software or proprietary codes possible. Public domain software is often not well-documented but is inexpensive. Proprietary software is generally more expensive but well-maintained and documented. The development of a code requires trained personnel, considerable computer resources, and a sound numerical solution approach. Seven components or considerations in the numerical solution approach are discussed with the treatment of the advection terms being of considerable importance. Finally, six elements of model performance evaluation are summarized and include a discussion of the types of data for such evaluations. (See also W89-01412 thru W89-01414 and W89-01416) (Author's abstract)
W89-01415

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART V,
For primary bibliographic entry see Field 2E.
W89-01416

COMPREHENSIVE METHOD OF CHARACTERISTICS MODELS FOR FLOW SIMULATION,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2E.
W89-01417

FINITE ELEMENT CHARACTERISTIC ADVECTION MODEL,
Rosenstiel School of Marine and Atmospheric Science, Miami, FL. Div. of Applied Marine Physics.
For primary bibliographic entry see Field 5B.
W89-01418

CLOUD DROPLETS: SOLUTE CONCENTRATION IS SIZE DEPENDENT,
Washington Univ., Seattle. Dept. of Civil Engineering.
K. J. Noone, R. J. Charlson, D. S. Covert, J. A. Ogren, and J. Heintzenberg.
Journal of Geophysical Research (D) JGRDE3, Vol. 93, No. 8, p 9477-9482, August 20, 1988. 5 fig, 1 tab, 23 ref. NSF Grants ATM 83-18028 and ATM 86-07377.

Descriptors: *Air pollution, *Acid rain, *Path of pollutants, *Cloud liquid water, *Fluid drops, Solutes, Chemical properties, Water chemistry, Sulfates.

Cloud droplets were sampled as function of their size using a counterflow virtual impactor. In a marine stratus cloud, the smaller droplets released smaller aerosol particles than did the larger droplets and the larger droplets released particles that are morphologically similar to sea salt. Aqueous solute concentrations for different droplet size ranges were calculated and it was concluded that: (1) The solute concentration within cloud droplets can be a function of the droplet size; in the cloud described here, the mass concentration in droplets larger than 9 micron diameter increased with size. (2) If the cloud droplet residue observed in this cloud is physically and chemically similar to aerosol observed at other remote marine locations, that is, the sub-micron particles are mainly sulfates and the super micron particles are mainly sea salt, then these data indicate that there are different ionic species in the smaller and larger droplets. The larger droplets would contain mainly sea salt, and the smaller droplets would contain more sulfate than the larger ones. (3) As the concentration of excess (non-sea-salt) sulfate controls the acid/base chemistry in background marine cloud water and because the droplet concentration was found to be size dependent (see conclusion one), the pH of cloud droplets and the chemistries depend on it (bisulfite and bisulfate ions) are size dependent. (4) As cloud droplets of differing concentration behave differently in a chemical sense, there is no single equilibrium statement governing all of the droplet sizes in a cloud. Because of this, bulk cloud water or rainwater composition may not be appropriate for modeling the chemical properties or reactions in clouds for investigating the effects of cloud water on biota or materials. Because the data presented here were taken from a single could under one synoptic condition, the variability in marine stratus clouds at this location is not yet known. It is known, however, that the residue aerosol size distributions derived from this cloud were similar to those derived from seven other clouds at the same location. (Hammond-PTT)
W89-01436

ENVIRONMENTAL ANALYSIS USING AN ENERGY-DISPERSIVE X-RAY FLUORESCENCE ANALYZER,
HNU Systems, Inc., Newton, MA.
J. N. Driscoll, and N. Jacobus.
American Laboratory ALBYBL, Vol. 20, No. 8, p 68, 70-75, 79, August 1988. 8 fig, 20 ref.

Descriptors: *Pollutant identification, *Chemical analysis, *X-ray fluorescence, *Sampling, *Computers, Energy-dispersive x-ray fluorescence analyzer.

The personal computer-controlled tube excited x-ray fluorescence analyzer is a versatile instrument for the analysis of a wide variety of environmental samples. For liquid samples, a multitude of elements can be detected at low ppm levels. Energy-dispersive x-ray fluorescence appears to be a useful screening tool for atomic absorption or inductively coupled plasma since it has a wider dynamic range than either method and can rapidly scan for multiple elements. Ion exchange can be used to improve selectivity. A concentration step can be used if ppb detection limits are required. Energy-dispersive x-ray fluorescence has been widely applied for the analysis of multiple elements in ambient air or in the workplace as a result of its excellent sensitivity and specificity in this application. Soil samples can be analyzed for multiple elements at low ppm levels. The use of an ultra-thin window in an energy-dispersive x-ray fluorescence system improved the detection of many light elements, some of which were important for environmental measurements. (Author's abstract)
W89-01439

LOW LEVELS OF COPPER AND LEAD IN A HIGHLY INDUSTRIALIZED RIVER,
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
L. Huynh-Ngoc, N. E. Whitehead, and B. Oregioni.
Toxicological and Environmental Chemistry TXECBP, Vol. 17, No. 3, p 223-236, 1988. 2 fig, 4 tab, 25 ref.

Descriptors: *Sampling, *Sample preservation, *Water analysis, *Rivers, *Heavy metals, *Path of pollutants, Copper, Lead, Sediments, Particulate matter, Industrial development.

A recent tabulation showed downward revision was necessary for the concentrations of many elements in sea water. The reason was the ubiquitous presence of contamination during sampling. It was common to add accidentally several micrograms/kg contamination to samples to be analyzed for Zn, Cu, Cd, Pb, Hg, and other elements. The true environmental concentrations of those elements were often at least ten or a hundred times lower than those observed. It was decided to apply some of the recent marine techniques to a study of the water of the Rhone. It was expected that the values obtained from this study might be slightly above background. Instead, the values obtained were so low that they reinforce doubts about the validity of the tabulated background values which suggest typical river water concentrations from

pristine rivers of 1500 and 100 ng/kg for Cu and Pb respectively, and particulate concentrations for both of 100 mg/kg. Dissolved Cu and Pb in the Rhone are 780 + or - 390 and 91 + or - 31 ng/kg, typical of pristine rivers. Suspended particulate matter contained 68 + or - 53 mg/kg and 60 + or - 30 mg/kg solid phase of Cu and Pb, respectively. Sediments contained 31 + or - 13 mg/kg and 37 + or - 9 mg/kg of Cu and Pb. The Pb values for sediments are only slightly above background levels. Less Cu was carried on particulate matter than expected. It is to be hoped that more resources will be diverted into establishing clear and valid background levels for values of Pb, Cu and Zn metals in river systems. Only then can the effects of added effluents from industry be fully and adequately judged, and the true state of the geochemical balance between river and sea properly revealed. Tabulated values of background levels of Cu and Pb in the literature may need some reexamination. (Hammond-PTT)
W89-01442

EFFECT OF PROLONGED EXPOSURE TO ACETYLENE ON DENITRIFICATION IN A LABORATORY STREAM SEDIMENT SYSTEM,
Oxford Univ. (England). Dept. of Plant Sciences.
J. G. Cooke, and R. E. White.
Water Research WATRAG, Vol. 22, No. 6, p 685-691, June 1988. 7 fig, 1 tab, 23 ref.

Descriptors: *Sediment-water interfaces, *Streams, *Stream sediments, *Denitrification, *Acetylene inhibition, *Nitrates, *Nitrites, Oxidation-reduction potential, Artificial watercourses, Enzymes, Heterotrophic bacteria, Diffusion, Biodegradation.

The effects of prolonged exposure to acetylene on denitrification activity in a sediment-water (0.5 millimole/cu dm Ca(NO3)2) system were studied in the laboratory to evaluate the possible use of the acetylene inhibition method for long-term in situ studies in streams. Denitrification accounted for 86% of the nitrate reduced in the acetylene-treated system. Acetylene addition induced anaerobic conditions within the top 5 mm of sediment after 2-3 days incubation that did not occur in the control treatment. This was accompanied by an increased rate of nitrate reduction and nitrite production in the recirculating 'stream water.' Analysis of the sectioned acetylene-treated sediment revealed much steeper nitrite and nitrate diffusion profiles than in the control. Enzyme assay showed that denitrification activity was six times higher than the initial level at the sediment-water interface of the acetylene treatment, and decreased with depth, whereas the control showed a much smaller peak at 5.5 mm depth. It is hypothesized that the results could be explained by heterotrophic degradation of acetylene, with subsequent utilization of the breakdown products by denitrifiers. (Author's abstract)
W89-01446

INORGANICS,
Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA. Montgomery Labs.
For primary bibliographic entry see Field 5A.
W89-01464

ORGANICS,
Tennessee Technological Univ., Cookeville.
For primary bibliographic entry see Field 5A.
W89-01465

WATER CHARACTERISTICS,
For primary bibliographic entry see Field 5A.
W89-01466

CONTINUOUS MONITORING, AUTOMATED ANALYSIS, AND SAMPLING PROCEDURES,
Oak Ridge National Lab., TN. Waste Management Technology Center.
R. L. Jolley, and A. L. Rivera.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 6, p 799-801, June 1988. 28 ref.

Descriptors: *Literature review, *Automation, *Measuring instruments, *Monitoring, *Data acquisition, *Sampling, *Water pollution control, *Water analysis, Computers, Control systems, Remote sensing, Color, Dissolved oxygen, Oxidation-reduction potential, Hydrogen ion concentration, Wastewater treatment facilities.

Literature published in 1987 on monitoring, automated analysis, and sampling as they relate to water pollution control is summarized under the following headings: monitoring and control strategies and continuous monitoring applications. Among the specific topics covered are computerized control systems, on-line instrumentation, monitoring of water parameters such as color, dissolved oxygen, and redox potential, and automated control of wastewater treatment plants. The review aims to include all pertinent, important and significant articles without evaluating their merit; when selections were made, availability of documents and the presence of new information in the article were used as inclusion criteria. A brief synopsis of the contents is given for each article cited. (Rochester-PTT)
W89-01467

SUBSTRATE ASSOCIATED MICROBIOTA,
Pennsylvania State Univ., University Park. School of Forest Resources.
For primary bibliographic entry see Field 5C.
W89-01505

DETERMINATION OF A REALISTIC ESTIMATE OF THE ACTUAL FORMATION PRODUCT THICKNESS USING MONITOR WELLS: A FIELD BAILOUT TEST,
S and ME, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5B.
W89-01544

RATIONALE FOR SAMPLING AND INTERPRETATION OF ECOLOGICAL DATA IN THE ASSESSMENT OF FRESHWATER ECOSYSTEMS.
American Society for Testing and Materials, Philadelphia, PA. A symposium sponsored by ASTM Committee D-19 on Water, Philadelphia, PA, 31 Oct.-1 Nov. 1983. ASTM Special Technical Publication 894. ASTM Publication Code Number 04-894000-16. 1986. 193p. Edited by Billy G. Isom.

Descriptors: *Data interpretation, *Sampling, *Lakes, *Water quality, *Symposium, *Environmental impact statement, Ecological effects, Environmental effects, Species composition, Electric powerplants, Algae, Macrophytes, Mussels, Nutrients, Ecosystems, Baseline studies.

Symposium papers are presented which develop rational bases for sampling various aquatic ecosystems and for assessing environmental hazards from the generated data. The first two papers deal with the importance of geographic, climatic, land surface forms, soils, land uses, river basins, and vegetation as factors in establishing reference sites on which to evaluate changes in the ecological integrity. Further, proven capabilities in sampling the water, sediment, and biota for the necessary physical, chemical, biological, and toxicological properties measurements should be demonstrated for credible useful and consistent results. All aspects of the program must be subjected to exacting quality assurance and control practices on sample collection, storage, and analyses. The next two papers deal with the special problems which arise when attempting to assess the impact on a specific organism from an environmental or ecological change and determine the source of that change. Other papers stress the necessity to consider not only the sampling and data gathering and the quality of the data but also the objective of the program, the limitations to the uses of the information, and the impact on the decisions that must be made. All the information contained herein should be valuable for those considering a program of sampling and analyzing an aquatic ecosystem for the assessment of the impact of ecological change and hazard. (See W89-01600 thru W89-01611) (Author's abstract)
W89-01599

AQUATIC MONITORING: A RATIONALE FOR OBTAINING AND INTERPRETING AQUATIC ECOSYSTEM CHEMICAL EXPOSURE DATA,
Monsanto Co., St. Louis, MO.
For primary bibliographic entry see Field 7A.
W89-01600

SAMPLING EFFORT REQUIRED TO FIND RARE SPECIES OF FRESHWATER MUSSELS,
Michigan Univ.-Dearborn.
For primary bibliographic entry see Field 7A.
W89-01602

RATIONALE AND SAMPLING DESIGNS FOR FRESHWATER MUSSELS UNIONIDAE IN STREAMS, LARGE RIVERS, IMPOUNDMENTS, AND LAKES,
Tennessee Valley Authority, Muscle Shoals, AL. Div. of Air and Water Resources.
For primary bibliographic entry see Field 7A.
W89-01603

CHARACTERIZING THE INFLUENCE OF NATURAL VARIABLES DURING ENVIRONMENTAL IMPACT ANALYSIS,
Tennessee Valley Authority, Norris. Engineering Lab.
For primary bibliographic entry see Field 7A.
W89-01604

CONCEPTUAL FRAMEWORK TO GUIDE AQUATIC MONITORING PROGRAM DESIGN FOR THERMAL ELECTRIC POWER PLANTS,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W89-01606

LEAF PROCESSING IN A RESERVOIR: AN EXPERIMENTAL APPROACH,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 7A.
W89-01609

DEVELOPING A SAMPLING STRATEGY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
For primary bibliographic entry see Field 7A.
W89-01611

FIXED-WALL VERSUS FLEXIBLE-WALL PERMEAMETERS,
Texas Univ., Austin. Dept. of Civil Engineering.
D. E. Daniel, D. C. Anderson, and S. S. Boynton.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 107-126, 10 fig, 1 tab, 14 ref. NSF Grant No. CEE-3204967 and U.S. EPA Cooperative Agreement CR-810165.

Descriptors: *Hydraulic conductivity, *Permeameters, *Cutoff walls, *Permeability coefficient, *Clays, Testing procedures, Comparison studies, Soil compaction, Leakage, Soil mechanics.

Permeameters are of two general types: fixed-wall and flexible-wall cells. A controversy has developed over which type of cell is best suited for measuring the hydraulic conductivity of relatively impermeable, fine-grained soils. The various types of permeameters are discussed and their relative advantages and disadvantages are listed. Differences in applied stress, boundary leakages, and degree of saturation are the major differences between cells. It is concluded that no one type of cell is best suited to all applications. Data show that the type of permeameter used has little effect for laboratory-compacted clay permeated with water but can have a major effect for clays permeated with concentrated organic chemicals. Fixed-wall cells are perhaps best suited to testing laboratory-com-

pacted clays that will be subjected to little or no effective overburden pressure in the field. Flexible-wall cells are better suited to testing undisturbed samples of soil (to minimize boundary leakages) and testing soils that will be subjected to significant effective stress. (See also W89-01612) (Author's abstract)
W89-01620

PROCEDURE AND EQUIPMENT FACTORS AFFECTING PERMEABILITY TESTING OF A BENTONITE-SAND LINER MATERIAL,
Wisconsin Univ.-Madison. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 8D.
W89-01623

FIELD PERMEABILITY TEST FOR CLAY LINERS,
Geo-Con, Inc., Pittsburgh, PA.
S. R. Day, and D. E. Daniel.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 276-288, 9 fig, 11 ref. EPA Cooperative Agreement CR-810165-01-0.

Descriptors: *Liners, *Infiltrometers, *Hydraulic conductivity, *Clays, *Linings, *Permeability, Finite element method, Mathematical models, Soil properties, Seepage control, Case studies, Soil compaction, Field tests, Infiltration.

A method of measuring the hydraulic conductivity of compacted clay liners in the field using single-ring infiltrometers has been developed. It is assumed that the ring has a diameter that is no less than the thickness of the clay liner and that the clay liner is underlain by a freely draining material with negligible suction. Finite element analyses were performed to develop correction factors that account for horizontal seepage for cases in which the ring infiltrometer is partially embedded into the liner. The correction factors were developed for a range in diameter of the ring and for ratios of horizontal to vertical hydraulic conductivity of 1, 10, and 100. Laboratory experiments were conducted to verify the results of finite-element analyses, but the laboratory results showed considerable scatter and were successful only in demonstrating that the finite-element results show the proper trends. Finally, the test method was tried in the field on a full-sized clay liner in which the actual hydraulic conductivity of the entire liner could be calculated from the known rate of leakage. The hydraulic conductivity measured in the infiltration test agreed almost perfectly with the computed overall hydraulic conductivity of the entire liner. It is concluded that the single-ring infiltration test can be used to measure the hydraulic conductivity of clay liners, although it is difficult to measure hydraulic conductivities that are substantially lower than 1 times 10 to the minus 7th power cm/second. In addition, the field tests may take several weeks to complete. (See also W89-01612) (Author's abstract)
W89-01631

HAZARDOUS AND INDUSTRIAL SOLID WASTE TESTING AND DISPOSAL: SIXTH VOLUME.
American Society for Testing and Materials, Philadelphia, PA. ASTM Special Technical Publication 933. ASTM Publication Code Number 04-933000-16. 1986. 471p. Edited by Douglas Lorenzen et al.

Descriptors: *Hazardous wastes, *Waste disposal, *Waste characteristics, *Path of pollutants, *Leaching, *Testing procedures, Water pollution prevention, Linings, Heavy metals, Waste management, Incineration, Models, Wastewater treatment, Sampling, Leachates, Industrial wastes.

This publication contains papers presented at two symposia: the Third International Symposium on Industrial and Hazardous Waste presented at Alexandria, Egypt, 24-27 June 1985, and the Symposium on Environmental Test Method Development presented at Colorado Springs, CO, 8-9 May 1985. This Special Technical Publication (STP) is the sixth volume of test methods developed by ASTM toward fulfilling the need for improved test methods relating to disposal, treatment, and characterization of hazardous and industrial solid wastes. About one-third of the presented papers at the two symposia were selected for publication. The 25 selected papers covered seven different subject areas: (1) contaminant and leaching assessments, (2) groundwater and contaminant migration assessments, (3) incineration of hazardous waste, (4) liner assessment, (5) site monitoring and assessments, (6) waste testing, and (7) waste treatment alternatives. It is the objective of these symposia to stimulate research and provide a forum for the exchange of new information and ideas on the management of hazardous and industrial waste. (See W89-01635 thru W89-01660) (Geiger-PTT)
W89-01634

REMOTE SENSING METHODS FOR WASTE SITE SUBSURFACE INVESTIGATIONS AND MONITORING,
Office of Radiation Programs, Las Vegas, NV.
D. T. Wruble, J. J. van Ee, and L. G. McMillion.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 243-253, 4 fig, 1 tab, 11 ref.

Descriptors: *Groundwater pollution, *Geophysical surveys, *Remote sensing, *Path of pollutants, *Aerial photography, *Infrared imagery, Monitoring, Waste disposal, Sampling, Plumes, Geophysics, Leaching.

Detection and monitoring of subsurface contamination at waste disposal or storage sites can be expensive and uncertain with traditional sampling and measurement techniques. Remote sensing methods can greatly aid characterization of the subsurface and detection of contaminants in the vicinity of waste deposits. Inexpensive aerial remote sensing, such as photography or infrared scanning, can indicate subsurface contaminant movement and structure. Resistivity surveys and other surface remote sensor applications develop further details on subsurface geology and plumes. Most importantly, development of detailed vertical profiles with subsurface sensors provides indispensable data for ultimate characterization of the subsurface environment. Subsurface geophysical remote sensing techniques commonly used for deep subsurface characterization associated with petroleum or mineral exploration must be modified to be used effectively in the shallow depth range associated with surface disposal or storage sites. (See also W89-01634) (Author's abstract)
W89-01648

COMPLEX MATRIX IN ENVIRONMENTAL CHEMISTRY FOR THE PETROCHEMICAL INDUSTRY,
Standard Oil Co. (Ohio), Cleveland. Research Center.
For primary bibliographic entry see Field 5A.
W89-01649

DEVELOPING GUIDES FOR SAMPLING AND ANALYSIS OF GROUND WATER,
Dow Chemical Co., Baton Rouge, LA. Louisiana Div.
For primary bibliographic entry see Field 7A.
W89-01653

SOIL MOISTURE MONITORING AND SAMPLING PROBE FOR UNDERGROUND STORAGE TANKS AND SURFACE IMPOUNDMENTS,
Wisconsin Univ., Madison. Dept. of Soil Science.
For primary bibliographic entry see Field 5A.
W89-01654

PRACTICES FOR SAMPLING SOLID WASTES FROM POINT DISCHARGES AND IMPOUNDMENTS,
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 7A.
W89-01655

ASTM STANDARD LEACH TEST D3986: A HISTORY,
U.S. Pollution Control, Inc., Oklahoma City, OK.
For primary bibliographic entry see Field 5A.
W89-01656

RESULTS OF AN INTERLABORATORY STUDY OF A COLUMN METHOD FOR LEACHING SOLID WASTES,
Western Michigan Univ., Kalamazoo.
For primary bibliographic entry see Field 5B.
W89-01657

BATCH TYPE 24-H DISTRIBUTION RATIO FOR CONTAMINANT ADSORPTION BY SOIL MATERIALS,
Illinois State Geological Survey Div., Champaign. Geochemistry Section.
R. A. Griffin, W. A. Sack, W. R. Roy, C. C. Ainsworth, and I. G. Krapac.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 390-408, 1 fig, 10 tab, 5 ref, append. U.S. Environmental Protection Agency Cooperative Agreement CR-810245-01.

Descriptors: *Standards, *Adsorption, *Path of pollutants, *Testing procedures, Kinetics, Soil properties, Leaching, Clays, Soil types, Mixing, Arsenic, Cadmium, Leachates.

An investigation was undertaken to develop a standardized batch adsorption procedure that uses the initial and 24-h solution concentrations to calculate a distribution ratio between solutes and soil materials. In developing these procedures, it was found that the method of mixing the solute-soil mixtures influenced the amounts of solute adsorbed. To ensure reproducibility, a National Bureau of Standards rotating tumbler was adopted as the mixing system. An interval of 24 h was established as a valid operational definition of reaction time for determining distribution ratio values. Interlaboratory testing was conducted with arsenic and cadmium using soil materials having a range in physiochemical properties. The interlaboratory coefficients of variation (CV) were generally less than 10%. The precision of a distribution ratio measurement for a species that meets the criteria of being stable and nonvolatile should yield percent CV within the range established. The method has not been tested for organic solutes and is not considered suitable for volatile chemical species. The method is considered a reliable and useful technique for comparing the adsorption properties of various soil materials under a given set of conditions. (See also W89-01634) (Author's abstract)
W89-01658

EVALUATION OF PAINT FILTER TEST METHOD TO DETERMINE FREE LIQUID IN WASTE SAMPLES,
Empire-Thomsen, Groton, NY.
For primary bibliographic entry see Field 5E.
W89-01659

ABSORPTION OF HALOGENATED ORGANIC COMPOUNDS BY POLYMER MATERIALS COMMONLY USED IN GROUND WATER MONITORS,
Gartner Lee Associates Ltd., Markham (Ontario).
For primary bibliographic entry see Field 5A.
W89-01674

GEOPHYSICAL SURVEY TO INVESTIGATE CONTAMINANT MIGRATION FROM A WASTE SITE,
Woodward-Clyde Consultants, Baton Rouge, LA.
For primary bibliographic entry see Field 5B.
W89-01677

IMPEDANCE COMPUTED TOMOGRAPHY ALGORITHM AND SYSTEM FOR GROUND WATER AND HAZARDOUS WASTE IMAGING,

Manitoba Univ., Winnipeg. Dept. of Electrical Engineering.
For primary bibliographic entry see Field 2F.
W89-01678

TOMOGRAPHIC IMAGING OF GROUND WATER POLLUTION PLUMES,
Faraci (E.J.) and Associates, Winnipeg (Manitoba).
For primary bibliographic entry see Field 2F.
W89-01679

PRACTICAL METHODOLOGY FOR PROCESSING AND VALIDATION OF WATER QUALITY DATA,
Hydrometrics, Inc., Helena, MT.
M. K. Botz.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 202-205, 2 fig, 9 ref.

Descriptors: *Water quality, *Pollutant identification, *Hydrologic data collection, *Data processing, *Statistical methods, Computers, Quality control.

The correctness of water quality data can be determined before inclusion in a data base by using a computer-based technique for data screening, testing and comparison. Ion balances, performance on quality control samples, and other tests of laboratory results are used to determine analytical accuracy and precision. Comparisons with past data using trend analysis, Student's t-tests, graphical plots and regression analyses also can identify analytical errors. After determination of data to be rejected, retesting of these samples for specific parameters and selection of final data values results in a significantly more reliable data base. (See also W89-01661) (Author's abstract)
W89-01684

SIMULATING TROUT FEEDING STATIONS IN INSTREAM FLOW MODELS,
Washington State Dept. of Game, Olympia.
For primary bibliographic entry see Field 2H.
W89-01741

UNDERGROUND STORAGE SYSTEMS: LEAK DETECTION AND MONITORING,
Groundwater Technology, Inc., Annapolis Junction, MD.
For primary bibliographic entry see Field 5A.
W89-01765

RECOMMENDED BIOLOGICAL INDICES FOR 301(H) MONITORING PROGRAMS,
Environmental Protection Agency, Washington, DC. Office of Marine and Estuarine Protection.
G. R. Bilyard, and M. B. Brooks-McAulillfe.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-221560. Price codes: A02 in paper copy, A01 in microfiche. EPA Report No. EPA 430/9-86-002, March 1987. 17 p, 1 tab, 52 ref.

Descriptors: *Water quality, *Regulations, *Environmental impact, *Bioindicators, *Standards, *Monitoring, Biological studies, Biomass, Species diversity.

The 301(h) regulations require dischargers to conduct periodic surveys of those biological communities that are most likely to be affected by the modified discharge. The data from these surveys are used to compare biological conditions in the vicinity of the discharge with biological conditions in reference areas. One approach to making such comparisons involves the use of biological indices that reduce complex data sets into simple numerical relationships. The purpose of this document is to develop recommendations of those indices that should be used in the interpretation of 301(h) biological monitoring data. The Bray-Curtis similarity index, flexible sorting strategy, group average sorting, dominance flexible sorting strategy, infaunal index, biomass estimates, Hurlbert's PIE diversity index, and the Shannon-Wiener H'index are discussed and evaluated. (Lantz-PTT)
W89-01812

VADOSE ZONE MODELING OF ORGANIC POLLUTANTS.
For primary bibliographic entry see Field 5B.
W89-01859

OVERVIEW OF TERRESTRIAL PROCESSES AND MODELING,
Aqua Terra Consultants, Palo Alto, CA.
For primary bibliographic entry see Field 5B.
W89-01860

PHENOMENOLOGICAL PERSPECTIVE OF ECOLOGICAL DEVELOPMENT,
Maryland Univ., Solomons. Chesapeake Biological Lab.
For primary bibliographic entry see Field 5C.
W89-01898

CAN BIOLOGICAL MONITORING EARLY WARNING SYSTEMS BE USEFUL IN DETECTING TOXIC MATERIALS IN WATER,
Army Medical Bioengineering Research and Development Lab., Fort Detrick, MD. Health Effects Research Div.
For primary bibliographic entry see Field 5A.
W89-01901

VALIDATION OF COLLABORATIVE TESTING GUIDELINES,
Environmental Protection Agency, Las Vegas, NV. Quality Assurance Div.
For primary bibliographic entry see Field 5A.
W89-01917

WHY ROUND-ROBIN TESTING WITH ZOOPLANKTON OFTEN FAILS TO PROVIDE ACCEPTABLE RESULTS,
Dow Chemical U.S.A., Midland, MI. Dept. of Environmental Quality.
For primary bibliographic entry see Field 5A.
W89-01918

FACTORS AFFECTING THE CULTURE OF DAPHNIA MAGNA,
Unilever Research Port Sunlight Lab., Bebington (England).
For primary bibliographic entry see Field 5A.
W89-01919

APPLICABILITY OF USING A SINGLE LABORATORY EVALUATION TO SELECT CANDIDATES FOR COLLABORATIVE TESTING: EXPERIENCE WITH A SOIL TOXICITY BIOASSAY,
North Texas State Univ., Denton. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5A.
W89-01923

NEW AQUATIC BIOASSAY TECHNIQUE USING WYEOMYIA SMITHII, THE PITCHER-PLANT MOSQUITO,
Air Force Occupational and Environmental Health Lab., Brooks AFB, TX.
For primary bibliographic entry see Field 5A.
W89-01937

EFFECTS OF SMALL FISH PREDATION ON MICROCOSM COMMUNITY BIOASSAY,
Washington Univ., Seattle. Coll. of Ocean and Fishery Sciences.
For primary bibliographic entry see Field 5A.
W89-01938

COMPARISON OF SYSTEM DESIGN AND REPRODUCIBILITY TO ESTIMATE BIOCONCENTRATION OF DI-N-HEXYLPHTHALATE BY DAPHNIA MAGNA,
New York Cooperative Fishery Research Unit, Ithaca, NY.
For primary bibliographic entry see Field 5A.
W89-01943

STATISTICAL TEST PROCEDURE FOR EFFLUENT TOXICITY SCREENING,
SCI Data Systems, Inc., Annapolis, MD.
For primary bibliographic entry see Field 5A.
W89-01949

ISOLATION AND CHEMICAL CHARACTERIZATION OF PETROLEUM REFINERY WASTEWATER FRACTIONS ACUTELY LETHAL TO DAPHNIA MAGNA,
Enwright Labs., Greenville, SC.
For primary bibliographic entry see Field 5A.
W89-01950

BIOLOGICAL IMPLICATIONS OF THE MANAGEMENT OF WASTE MATERIALS: THE IMPORTANCE OF INTEGRATING MEASURES OF EXPOSURE, UPTAKE, AND EFFECTS,
National Ocean Service, Seattle, WA. Ocean Assessments Div.
For primary bibliographic entry see Field 7A.
W89-01951

USING THE NATURAL DETOXIFICATION CAPACITIES OF MARINE ORGANISMS TO ASSESS ASSIMILATIVE CAPACITY,
Southern California Coastal Water Research Project Authority, Long Beach.
For primary bibliographic entry see Field 5B.
W89-01953

MODEL FOR PREDICTING THE INFLUENCE OF SUSPENDED SEDIMENTS ON THE BIOAVAILABILITY OF NEUTRAL ORGANIC CHEMICALS IN THE WATER COMPARTMENT,
Monsanto Co., St. Louis, MO.
C. A. Staples, K. L. Dickson, J. H. Rodgers, and F. Y. Saleh.
IN: Aquatic Toxicology and Hazard Assessment: Seventh Symposium. A Symposium Sponsored by American Society for Testing and Materials Committee E-47 on Biological Effects and Environmental Fate, Milwaukee, Wisconsin, April 17-19, 1983. ASTM Special Technical Publication 854, 1985. p 417-428, 2 fig, 5 tab, 21 ref.

Descriptors: *Path of pollutants, *Toxicology, *Aquatic toxicology, *Model studies, *Suspended sediments, *Organic compounds, *Bioavailability, Water pollution effects, Water quality, Suspended solids, Dieldrin, Acenaphthene, Chrysene, Chemical analysis.

Site-specific water quality criteria may evolve from national water quality criteria based on site water characteristics. Suspended solids may be an important modifying parameter. A model is presented relating suspended solids characteristics (organic carbon content and suspended solids concentration) with a neutral organic chemical's sorption coefficient. Investigation of case studies with acenaphthene, dieldrin, and chrysene shows the dissolved and particulate-bound fractions (C sub d and C sub p) of total chemical concentration (C sub t) to be dependent upon these factors. The model may be used to predict C sub p and C sub d in site waters. The model shows that chemicals with low K sub p values in the presence of low suspended solids concentrations and organic matter are relatively unaffected by suspended solids. Conversely, chemicals with high K sub p values, high suspended solids concentrations, and organic matter would be primarily sorbed to suspended solids. (See also W89-01930) (Author's abstract)
W89-01956

BASIC PRINCIPLES AND PRACTICES ON THE ANALYSIS OF PESTICIDES,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5A.

W89-01970

POSITIVE IDENTIFICATION OF PESTICIDE RESIDUES BY CHEMICAL DERIVATIZATION-GAS CHROMATOGRAPHIC TECHNIQUE,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5A.
W89-01971

ANALYSIS OF PESTICIDES IN WATER. VOLUME II: CHLORINE- AND PHOSPHORUS-CONTAINING PESTICIDES.
For primary bibliographic entry see Field 5A.
W89-01973

ORGANOCHLORINE PESTICIDES,
National Water Research Inst., Burlington (Ontario). Analytical Methods Div.
For primary bibliographic entry see Field 5A.
W89-01974

ANALYSIS OF PESTICIDES IN WATER. VOLUME III: NITROGEN-CONTAINING PESTICIDES.
For primary bibliographic entry see Field 5A.
W89-01977

MODERN TRENDS IN TRACER HYDROLOGY. VOLUME I.
For primary bibliographic entry see Field 2F.
W89-01981

HYDROLOGICAL TRACERS,
Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
E. Gaspar.
IN: Modern Trends in Tracer Hydrology. Volume I. CRC Press, Inc., Boca Raton, FL. 1987. p 1-48, 21 fig, 3 tab, 131 ref.

Descriptors: *Groundwater movement, *Hydrologic studies, *Tracers, *Radioactive tracers, Dye releases, Fluorescence, Biological studies, Radioisotopes.

There is no such thing as a perfect tracer. However, the concept of an ideal tracer proves useful in the selection of artificial tracers, the search for environmental tracers, and, more particularly, the development of mathematical models. An ideal tracer should boast a number of properties; so, for instance, it should be easily detectable, used in small quantities, not modify the hydraulic characteristics of the aquifer, be inexpensive to purchase and use, not be sorbed by the medium, have (if radioactive) a useful half-life and low toxicity, and not appear in large amounts in the tracer medium. Tracer methods are employed in hydrology to detect and measure water flow characteristics. They are regular methods of work which hydrologists may easily apply to: rapid assessment; obtaining more accurate data; quantitative measurements; performance of difficult operations, such as the establishment of interaquifer connections; economic measurements; and obtainment of data in the case of which the application of other methods would yield no results. The substances most liable to behave the way water does in a given environment are those whose peripheral electrons boast sizes and densities similar to those of the water molecules. This chapter devotes itself to the study of the following classes of tracers: (1) chemical tracers; (2) fluorescent dye tracers; (3) radioactive tracers; (4) activable tracers; (5) biological tracers; (6) surface-active tracers; (7) episodic tracers; and (8) environmental isotopes. (See also W89-01981) (Lantz-PTT)
W89-01982

BEHAVIOR OF ARTIFICIAL TRACERS,
Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
E. Gaspar.
IN: Modern Trends in Tracer Hydrology. Volume I. CRC Press, Inc., Boca Raton, FL. 1987. p 49-79, 5 fig, 52 ref.

Descriptors: *Artificial tracers, *Tracers, *Hydrologic studies, *Groundwater movement, Chemical properties, Physical properties, Sorption, Toxicity, Costs.

The only way to determine whether a tracer may be chemically representative for a certain element is to use that element. For instance, in the study of pollution with pesticides one may note that after utilization they divide into three components: a part migrates along with the water, a part remains in the soil, and another part is incorporated by plants. For instance, some pesticides contain H, C, Cu, Cl, or Br in their molecule. Therefore, synthesizing the product and labeling it with 3-H, 14-C, 64-Cu, or 82-Br, a pollution tracer is obtained which is both an intrinsic and a representative tracer. However, impurities may easily lead to incorrect results. If radioactive impurities are tolerated adequate measures should be taken for measurement, like, for instance, the use of spectrometric methods. However, the behavior of radioactive impurities in the traced medium may be (and generally is) different from that of the tracer. There are three types of impurities: natural, isotopic, and technological. Other factors which can influence the behavior of tracers discussed include: (1) hydraulic compatibility; (2) the nature of investigated media; (3) the physicochemical properties of tracers; (4) tracer stability; (5) sorption; (6) tracer toxicity; and (7) cost and availability. (See also W89-01981) (Lantz-PTT)
W89-01983

TRACER METHODOLOGY IN HYDROLOGY,
Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
For primary bibliographic entry see Field 2A.
W89-01984

MODERN TRENDS IN TRACER HYDROLOGY. VOLUME II.
For primary bibliographic entry see Field 2F.
W89-01986

CHARACTERISTICS OF AQUIFERS IN POROUS MEDIA,
Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
For primary bibliographic entry see Field 2F.
W89-01987

FLOWTHROUGH HYDROKARSTIC STRUCTURES,
Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
For primary bibliographic entry see Field 2F.
W89-01988

TRACER INVESTIGATIONS IN GEOTHERMAL SYSTEMS,
Institutul de Meteorologie si Hidrologie, Bucharest (Romania). Environmental Isotope Lab.
For primary bibliographic entry see Field 2F.
W89-01989

VARIATION IN QUANTIFICATION OF CONCENTRATIONS OF TOXIC CHEMICALS IN FISH FROM THE LAURENTIAN GREAT LAKES: THE GOOD, THE BAD AND THE MANAGEABLE,
Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 5B.
W89-02122

EVALUATION OF TOXICITY PROFILES OF ORGANIC CHEMICALS: USEFULNESS OF ECOTOXICOLOGICAL BASIC TEST SET OF OECD,
Chemicals Inspection and Testing Inst., Oita (Japan). Hita Research Labs.
For primary bibliographic entry see Field 5A.
W89-02129

INDEXES FOR ASSESSING FISH BIOMASS AND YIELD IN RESERVOIRS,
Aquatic Ecosystem Analysts, Fayetteville, AR.
For primary bibliographic entry see Field 7C.
W89-02146

NATIONAL PESTICIDES IN WELL WATER SURVEY,
Environmental Protection Agency, Chicago, IL. Environmental Services Div.
For primary bibliographic entry see Field 5A.
W89-02213

REVIEW OF SOME OF THE PHYSICAL, CHEMICAL AND ISOTOPIC TECHNIQUES AVAILABLE FOR ESTIMATING GROUNDWATER RECHARGE,
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Soils.
For primary bibliographic entry see Field 2F.
W89-02227

SATELLITE REMOTE SENSING AND ENERGY BALANCE MODELLING FOR WATER BALANCE ASSESSMENT IN (SEMI-) ARID REGIONS,
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
A. A. van de Griend, and R. J. Gurney.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 89-116, 10 fig, 1 tab, 46 ref.

Descriptors: *Remote sensing, *Hydrologic budget, *Semiarid lands, *Satellite technology, *Arid lands, *Soil water, *Data acquisition, *Model studies, Satellite technology, Energy, Monitoring, Infrared radiation, Microwaves, Evapotranspiration.

The terms of the water balance in semi-arid regions may be monitored using different types of remotely sensed information from satellites. Such an integrated approach focuses on the possibilities of monitoring the soil moisture status and evapotranspiration over time from the combination of: (1) thermal infrared, (c) visible and near infrared, and (3) passive microwave remote sensing. Actual recharge depends on subsurface geohydrological conditions for percolation to underlying aquifers, and may vary between localized concentrated percolation on the one hand and more regional diffuse percolation on the other. The surface energy balance may be modelled using thermal infrared surface temperature observations and large scale, near surface meteorological information, which allows the evapotranspiration rate to be estimated and the soil moisture status to be inferred together with stress conditions of the vegetation. This requires a remotely sensed estimate of the vegetation cover and biomass which may be derived from visible and NIR signatures. Separately, the soil moisture status of the top soil may be derived from passive microwave signatures. (See also W89-02223) (Lantz-PTT)
W89-02229

NATURAL RECHARGE MEASUREMENTS IN THE HARD ROCK REGIONS OF SEMI-ARID INDIA USING TRITIUM INJECTION - A REVIEW,
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
R. N. Athavale, and R. Rangarajan.
IN: Estimation of Natural Groundwater Recharge. Mathematical and Physical Sciences Vol. 222. D. Reidel Publishing Co., Boston, Massachusetts. 1988. p 175-194, 6 fig, 2 tab, 14 ref.

Descriptors: *Groundwater recharge, *Data acquisition, *Semiarid lands, *Recharge, *Tracers, *India, *Tritium, Injection, Rocks, Monsoon, Soil water, Aquifers, Rainfall, Precipitation.

Hard rocks cover about 66% of the land area of India. They are mainly located in the semi-arid tropical belt characterized by seasonal (monsoonal) precipitation. The main rock types are Granites and Basalt and the corresponding soil types are Alfisols and Vertisols. Natural recharge to phreatic aquifers of this region has been estimated in the case of several large basins (area 500 sq km and more) and two watersheds (area around 50 sq km) using the Tritium injection technique. Tritium was injected at representative sites before onset of monsoon and the displacement of Tritium peak and variation of moisture content in vertical soil profiles collected in post-monsoon period were used for determining spot values of recharge due to precipitation. The average recharge values show a range from almost nil to about 100 mm depending upon the soil type, temperature, rainfall amount and pattern, geohydrological conditions etc. Systematic recharge measurements over large areas would provide a useful basis for optimal utilization of the replenishable but limited groundwater reserves of semiarid tropical regions. The recharge measurements will also form a primary database for artificial recharge programs which would be needed for meeting the increasing demand for groundwater by farmers of the semiarid tropical regions. (See also W89-02223) (Lantz-PTT)
W89-02234

COMPARISON OF RECHARGE ESTIMATES FROM INJECTED TRITIUM TECHNIQUE AND REGIONAL HYDROLOGICAL MODELLING IN THE CASE OF A GRANITIC BASIN IN SEMIARID INDIA,
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 2F.
W89-02235

NUMERICAL AND CONCEPTUAL MODELS FOR RECHARGE ESTIMATION IN ARID AND SEMI-ARID ZONES,
Birmingham Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-02237

PRINCIPLES OF INVERSE MODELLING FOR ESTIMATION OF RECHARGE FROM HYDRAULIC HEAD,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Groundwater Research.
For primary bibliographic entry see Field 2F.
W89-02239

ESTIMATING NATURAL RECHARGE OF GROUND WATER BY MOISTURE ACCOUNTING AND CONVOLUTION,
Orange Free State Univ., Bloemfontein (South Africa). Inst. vir Grondwaterstudies.
For primary bibliographic entry see Field 2F.
W89-02240

BALSEQ - A MODEL FOR THE ESTIMATING OF WATER BALANCES, INCLUDING AQUIFER RECHARGES, REQUIRING SCARCE HYDROLOGIC DATA,
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
For primary bibliographic entry see Field 2F.
W89-02242

GROUNDWATER RECHARGE FROM THREE CHEAP AND INDEPENDENT METHODS IN THE SMALL WATERSHEDS OF THE RAIN FOREST BELT OF NIGERIA,
Nigeria Univ., Nsukka. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W89-02251

SIMPLE ANALYTICAL METHODS FOR ESTIMATING SHORT-TERM RAINFALL,
Army Topographic Command, Washington, DC.
For primary bibliographic entry see Field 2B.
W89-02261

NODAL DOMAIN INTEGRATION MODEL OF TWO-DIMENSIONAL HEAT AND SOIL-WATER FLOW COUPLED BY SOIL-WATER PHASE CHANGE,
Williamson and Schmid, Irvine, CA.
For primary bibliographic entry see Field 2G.
W89-02265

TOXICITY ASSAYS AND MOLECULAR STRUCTURE TOXICITY,
Drexel Univ., Philadelphia, PA.
For primary bibliographic entry see Field 5D.
W89-02270

COMPETITIVE KINETIC MODEL OF SUSPENDED-GROWTH INHIBITED BIOLOGICAL SYSTEMS,
Pontificia Univ. Catolica de Chile, Santiago. Dept. of Hydraulic Engineering.
For primary bibliographic entry see Field 5D.
W89-02271

7C. Evaluation, Processing and Publication

RIVER-BEND CURVATURE AND MIGRATION: HOW ARE THEY RELATED,
Florida State Univ., Tallahassee. Dept. of Geology.
For primary bibliographic entry see Field 2J.
W89-01336

GROUNDWATER QUALITY BENEATH THE CITY OF LONDON: OVERVIEW AND LONG-TERM CHANGES,
For primary bibliographic entry see Field 5B.
W89-01353

BETTER THAN 'OPTIMAL' METHOD FOR DESIGNING DRAINAGE SYSTEMS,
CDM, Raleigh, NC.
For primary bibliographic entry see Field 4A.
W89-01365

OBJECTIVE RAINFALL EVALUATION IN RADAR HYDROLOGY,
INTERA Technologies Ltd., Calgary (Alberta).
N. R. Dalezios.
Journal of Water Resources Planning and Management (ASCE) JWPED5, Vol. 114, No. 5, p 531-546, September 1988. 5 fig, 2 tab, 20 ref.

Descriptors: *Statistical analysis, *Rainfall, *Radar, *Depth-area-duration analysis, *Areal precipitation, Weather data collections, Comparison studies, Rain gages, Rainstorms, Precipitation, Grand River Basin, Canada, Performance evaluation.

A newly developed bivariate statistical analysis is compared to several rainfall analyses, namely the radar univariate analysis, the reciprocal-distance raingage interpolation model, the Brandes field adjustment procedure, and the 'optimum' raingage analysis. A number of statistics also are computed and used to evaluate the results. Several warm-season storms are examined over the Grand River Basin above Cambridge in southern Canada. Based on the selected criteria, the analyzed storms indicate that, in general, most of the techniques in the comparison performed similarly, with the exception of the radar univariate analysis, which is considered unsatisfactory. (Author's abstract)
W89-01368

SPATIAL CORRELATION OF HYDROLOGIC TIME SERIES,
Miami Univ., Coral Gables, FL. Dept. of Civil and Architectural Engineering.
D. A. Chin.
Journal of Water Resources Planning and Management (ASCE) JWPED5, Vol. 114, No. 5, p 578-593, September 1988. 11 tab, 5 ref.

Descriptors: *Statistical methods, *Time series analysis, *Correlation analysis, *Hydrologic data collections, *Estimating, Data interpretation, Fluctuations, Statistical methods, Missing data, Unconfined aquifers, Water table fluctuations, Florida.

A methodology for extracting random components and estimating the relationship between coherent components of hydrologic time series is presented. The technique has been verified using synthetic data and validated using measured data. The results show that random component statistics are accurately estimated, and the correct relation between pairs of stationary and nonstationary time series are estimated for frequency components whose amplitude significantly exceeds the standard deviation of the random component. Applying the method to measured, nonstationary hydrologic data (water table fluctuations in the unconfined Biscayne aquifer, Florida) demonstrated that the technique was able to accurately predict the measured fluctuations in 9 of the 12 years considered. Significant portions of the spectrum of the measured series were found to have characteristics consistent with the existence of a random component. A primary application of the results of this study is to fill in missing data at one location based on measured data at an adjacent location. (Author's abstract)
W89-01371

HEALTH ASPECTS OF THE USE OF RECYCLED WATER IN WINDHOEK, SWA/NAMIBIA, 1974-1983,
University of the Witwatersrand, Johannesburg (South Africa).
For primary bibliographic entry see Field 5F.
W89-01378

INTERPRETATION OF WELL AND FIELD DATA IN A HETEROGENEOUS LAYERED AQUIFER SETTING, APPALACHIAN PLATEAU,
Northern Illinois Univ., De Kalb. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W89-01405

THREE-DIMENSIONAL, CROSS-SEMIVARIOGRAM CALCULATIONS FOR HYDROGEOLOGICAL DATA,
Oregon State Univ., Corvallis. Dept. of Agricultural Engineering.
J. D. Istok, R. M. Cooper, and A. L. Flint.
Ground Water GRWAAR, Vol. 26, No. 5, p 638-646, September-October 1988. 3 fig, 6 tab, 12 ref.

Descriptors: *Data interpretation, *Statistical methods, *Geohydrology, *Computer programs, *Multivariate analysis, Fortran, Automation, Computers.

Geostatistics is a powerful tool for the analysis of hydrogeological data, but few well-documented computer programs for performing the necessary calculations have been presented in the technical literature. This is especially true for applications that require either three-dimensional or multivariate analyses. FORTRAN subroutine, VARIO, that can be used to compute experimental direct and cross semivariograms from a set of sample data, for any specified direction in one-, two-, or three-dimensional space is described. The subroutine combines into groups those sample pairs that fall within predetermined angular tolerances of the specified direction. The number of sample pairs used to compute the value of the experimental semivariogram at each value of separation can be specified in four different ways, depending on the nature of the available data. Written in FORTRAN 77, VARIO can be used on any computer that supports a FORTRAN 77 compiler. Source code listing, user instructions, and example input and output data for VARIO are presented. (Author's abstract)
W89-01410

DEVELOPMENT AND APPLICATION OF A GROUND WATER MODELING DATABASE AND EXPERT SYSTEM,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
C. J. Newell, and P. B. Bedient.
IN: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water-Prevention, Detection and Restoration. National Water Well Association, Dublin, OH. 1987. p 559-578, 7 fig, 1 tab, 8 ref.

Descriptors: *Model studies, *Data bases, *Geohydrology, *Monte Carlo method, *Hazardous wastes, *Aquifer characteristics, Hydrologic data collections, Site selection, Groundwater management, Statistical methods, Land disposal, Waste disposal, Geohydrology, Expert systems.

Statistical groundwater models using a Monte Carlo approach are being proposed by the EPA as a screening tool for the land disposal of hazardous wastes. One limitation to the proposed approach is that the screening method assumes a nationwide distribution of aquifer parameters, making it difficult to account for site specific conditions. The goal of this research is to develop an integrated computer system consisting of a new hydrogeologic database, a stochastic model, and an expert system that will expand the capabilities of the regulatory groundwater model. The database is being developed from actual field data collected from an extensive technical survey of groundwater professionals. The technical survey is being conducted together with the NWWA and is funded by the American Petroleum Institute to gather data on the large number of hydrogeologic investigations that have been conducted to characterize waste sites but have not been reported in the technical literature. The hydrogeologic database is being organized into hydrogeologic settings, with each setting having statistical distributions of aquifer parameters. The division into hydrogeologic settings allows more of a site specific approach to Monte Carlo groundwater modeling. A potential user of the hydrogeologic database will be assisted by an expert system. The expert system will provide the necessary knowledge to help the user select the correct hydrogeologic settings for a particular site of interest. Data associated with the setting will then be available for characterization of the site or for use in a stochastic groundwater model. A prototype expert system for selecting hydrogeologic settings has now been developed and evaluated. (See also W89-01530) (Author's abstract)
W89-01563

RATIONALE FOR SAMPLING AND INTERPRETATION OF ECOLOGICAL DATA IN THE ASSESSMENT OF FRESHWATER ECOSYSTEMS.
For primary bibliographic entry see Field 7B.
W89-01599

RATIONALE FOR DATA COLLECTION AND INTERPRETATION IN THE NORTHERN LAKES LONG-TERM ECOLOGICAL RESEARCH PROGRAM,
Wisconsin Univ.-Madison. Center for Limnology.
For primary bibliographic entry see Field 7A.
W89-01601

INTERPRETATION OF IN SITU GROUNDWATER QUALITY FROM WELL SAMPLES,
I. Metzger.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 76-85, 7 fig, 2 tab, 7 ref.

Descriptors: *Water quality, *Groundwater quality, *Monitoring, *Path of pollutants, *Sampling, *Data interpretation, Test wells, Theoretical analysis, Sampling, Groundwater recharge, Zinc, Biochemical oxygen demand, Iron, Manganese, Lead, Phenols, Color, Turbidity, Landfills, Leaching.

The differences between water quality determinations made from monitoring wells and actual in situ groundwater quality or projected quality as withdrawn from water supply wells may be significant, and misleading. For unconfined aquifers, several factors regarding monitoring wells can influence water quality withdrawn from them in comparison with in situ conditions. Bacterial growth on screens required on some monitoring wells may change water quality. The exchange of gases, diffusion, and mixing may be affected by sustained pumpage at a well, such as a water supply well. Sampling procedures may also disturb water quality. Groundwater quality observations were made for a 200,000 sq m existing landfill for leachate control purposes, and for planning and design of a 40,000 sq m expansion along the southerly boundary. Field measurements reported in original planning studies for the landfill were used to estimate the water contours as they existed prior to landfilling. The effects of landfilling on groundwater recharge and movement are discussed. Since 1976, annual samples from the monitoring wells have been taken for testing of water quality parameters. The number of annual samples which exceeded drinking water criteria are tallied and discussed in relation to turbidity, color, lead, iron, manganese, zinc, biochemical oxygen demand, and phenol. (See also W89-01599) (Author's abstract)
W89-01605

USE OF DETRENDED CORRESPONDENCE ANALYSIS IN EVALUATING FACTORS CONTROLLING SPECIES COMPOSITION OF PERIPHYTON,
Geological Survey, Menlo Park, CA. Water Resources Div.
H. V. Leland, and J. L. Carter.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 101-117, 7 fig, 1 tab, 41 ref.

Descriptors: *Statistical analysis, *Species composition, *Periphyton, *Environmental effects, *Aquatic plants, *Water pollution effects, *Copper, Ecological effects, Streams, Toxicity, Succession, Plant populations, Spatial distribution, Temporal distribution.

Detrended correspondence analysis (DCA) was evaluated for its usefulness in elucidating relationships among samples and among species of periphyton in an oligotrophic stream, and for its effectiveness in displaying major gradients where an experimental gradient (copper) affecting species composition was imposed. It was highly sensitive to differences among samples and consistently provided ecologically meaningful species ordination. Gradients related to seasonality of taxa and year-to-year differences in population densities were evident in DCA ordinations if data for all sampling dates were included, and these gradients complicated interpretation of the copper gradient. Clear discontinuities between samples in control and copper-treated stream sections existed only if data for each sampling date were ordinated separately. Prior to copper exposure, stage of succession of the community was the major gradient displayed in species ordinations. During periods of exposure, sensitivity of taxa to copper was the primary factor controlling the spatial distribution of periphyton. Stage of succession was a secondary gradient during exposure and complicated interpretation of the copper gradient after a major disturbance event (flooding). (See also W89-01599) (Author's abstract)
W89-01607

SAMPLING AND INTERPRETATION OF ALGAL PATTERNS FOR WATER QUALITY ASSESSMENTS,
Louisville Univ., KY. Dept. of Biology.
R. J. Stevenson, and R. L. Lowe.
IN: Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems. American Society for Testing and Materials, Philadelphia, PA. 1986. p 118-149, 1 fig, 146 ref.

Descriptors: *Water quality, *Algae, *Aquatic productivity, *Ecological effects, *Monitoring, *Sampling, Aquatic populations, Population dynamics, Diatoms, Species diversity, Environmental effects, Data interpretation, Habitats, Species composition.

Algal studies are valuable in water quality assessment because of their importance in aquatic ecosystems and sensitivity to changes in habitat conditions. Recent advances in algal ecology and sample analysis enable the designing of research that more directly reveals patterns of algal community structure and function that are pertinent to different kinds of environmental perturbations. In addition, advances in quantitative algal ecology enable more accurate interpretation of the importance of environmental perturbations on algal community structure and function. Recent advances in algal ecology are incorpoarted into suggestions on how to design algal research for water quality assessment and methods for sample analysis, presents statistical techniques which can be useful for analyzing results, and reviews interpretations of the results. (See also W89-01599) (Author's abstract)
W89-01608

LOW-COST DATA MANAGEMENT FOR PROTECTION OF GROUND-WATER RESOURCES: THE IMPORTANCE OF QUALITY ASSURANCE,
Louisiana Dept. of Environmental Quality, Baton Rouge.
W. B. DeVille, and J. A. Malloy.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 104-119, 3 fig, 7 ref.

Descriptors: *Water quality, *Hazardous wastes, *Computers programs, *Data processing, *Data storage and retrieval, *Hydrologic data collections, Groundwater management, Monitoring, Waste disposal, Statistical methods.

U.S. environmental regulations require the collection, statistical evaluation, and reporting of data associated with ground-water monitoring at hazardous waste facilities. Desktop personal computers are capable of managing the large volume of data and automatically generating the required reports. A functional data base for groundwater monitoring data has been developed for the Apple II personal computer. Design emphasis was placed on error-checking during data entry and on simplicity and consistency of all operations available to the user. This should be considered an integral part of quality assurance/quality control considerations, not only throughout the operations of sampling and chemical and physical measurements, but also throughout all operations involving data entry, storage, manipulation, and reporting. The programming language used in data base development (a structured BASIC) was chosen to facilitate testing and debugging of program modules. A major design objective was to assure that all operations involved in entry, storage, manipulation, and statistical evaluation of data are well-documented and bug-free. (See also W89-01634) (Author's abstract)
W89-01641

PRACTICAL METHODOLOGY FOR PROCESSING AND VALIDATION OF WATER QUALITY DATA,
Hydrometrics, Inc., Helena, MT.
For primary bibliographic entry see Field 7B.
W89-01684

STREAMFLOW GENERATION BY VARIABLE SOURCE AREA,
Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab.
For primary bibliographic entry see Field 2E.
W89-01699

FOREST ECOSYSTEM STABILITY: REVISION OF THE RESISTANCE-RESILIENCE MODEL IN RELATION TO OBSERVABLE MACROSCOPIC PROPERTIES OF ECOSYSTEMS,

Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
For primary bibliographic entry see Field 2A.
W89-01712

CRITIQUE OF THE INSTREAM FLOW INCREMENTAL METHODOLOGY AND OBSERVATIONS ON FLOW DETERMINATION IN NEW ZEALAND,
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
D. Scott, and C. S. Shirvell.
IN: Regulated Streams: Advances in Ecology. Plenum Press, New York, 1987. p 27-43, 4 fig, 4 tab, 57 ref.

Descriptors: *Data interpretation, *Instream flow, *New Zealand, *Streamflow, Ecosystems, Instream flow incremental methodology, Aquatic habitats, Water depth, Flow velocity, Mathematical studies.

The Instream Flow Incremental Methodology (IFIM), a model developed by the Instream Flow Group (IFG), is composed of components which simulate water temperature, water quality, and physical habitat. The physical habitat components (PHABSIM), however, is so frequently the only part of the method used that PHABSIM and IFIM are often confused. PHABSIM is based on several assumptions which are not always met. These assumptions are: (1) that water depth, water velocity, and substrate size are the only physical habitat variables determining position choice by fish; (2) that Manning's n remains constant with changes in streamflow; (3) that mean water velocities in individual cells change in the same way as the mean velocity for a cross-section with changes in streamflow; (4) that water velocities at 6/10 of the depth affect fish preference; (5) that habitat preference curves can be treated as probability functions; (6) that habitat variables are independent in their influence on position choice; (7) that large areas of less than optimum habitat have the same productive capacity as small areas of optimum habitat; and (8) that areas of stream not occupied by fish are useless. The assumptions in PHABSIM need to be carefully examined to see how they affect the usefulness of the model: variability in fish behavior whether learned or genetic suggests that preference curves should be constructed for each river, or at least for river classes. The estimation of weighted usable level is not an end in itself, and unless the relation of this index to fish biomass is well validated, it is difficult to see how it can be used decisively at the judicial level. (See also W89-01736) (Lantz-PTT)
W89-01738

INTERCALIBRATION OF ANALYTICAL METHODS ON MARINE ENVIRONMENTAL SAMPLES. RESULTS OF MEDPOL-II EXERCISE FOR THE INTERCALIBRATION OF CHLORINATED HYDROCARBON MEASUREMENTS ON MUSSEL HOMOGENATE (MA-M-2/OC).
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
For primary bibliographic entry see Field 5A.
W89-01780

MODELING GROUNDWATER FLOW AND POLLUTION: WITH COMPUTER PROGRAMS FOR SAMPLE CASES,
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-01810

GENERIC STEPS IN THE FIELD VALIDATION OF VADOSE ZONE FATE AND TRANSPORT MODELS,
Environmental Protection Agency, Las Vegas, NV.
S. C. Hern, S. M. Melancon, and J. E. Pollard.
IN: Vadose Zone Modeling of Organic Pollutants. Lewis Publishers, Inc., Chelsea, Michigan. 1986. p 61-80, 1 fig, 3 tab, 31 ref.

Descriptors: *Field tests, *Data interpretation, *Vadose water, *Path of pollutants, *Model studies, *Fate of pollutants, Organic compounds, Solute transport.

The primary emphasis of this chapter is on the transport and fate of organic chemicals in the vadose zone, i.e., from the soil surface to the groundwater table. Model validation is defined in this report as comparison of model results with numerical environmental data collected in the field or in laboratory observations. Complete model validation requires testing over the full range of conditions for which predictions are intended. At a minimum, this requires a series of validations in various climates and soil types with chemicals that typify the major fate and transport processes. In this chapter, suggested generic approaches to model validation are presented, but the reader should be aware that many validation problems are specific to a particular site, compound, or model and must be dealt with on a case-by-case basis. The suggested steps in field validation of soil fate and transport models are: (1) Identify Model User's Need; (2) Examine the Model; (3) Evaluate the feasibility of field validation; (4) Develop acceptance criteria for validations; (5) Determine field validation scenario; and (6) Plan and conduct field validations. (See also W89-01859) (Lantz-PTT)
W89-01862

EXAMPLE FIELD TESTING OF SOIL FATE AND TRANSPORT MODEL, PRZM, DOUGHERTY PLAIN, GEORGIA,
Environmental Protection Agency, Las Vegas, NV.
For primary bibliographic entry see Field 5B.
W89-01863

EXAMPLE MODEL TESTING STUDIES,
Aqua Terra Consultants, Palo Alto, CA.
A. S. Donigian, and P. S. C. Rao.
IN: Vadose Zone Modeling of Organic Pollutants. Lewis Publishers, Inc., Chelsea, Michigan. 1986. p 103-131, 8 fig, 7 tab, 40 ref.

Descriptors: *Model studies, *Path of pollutants, *Data interpretation, *Field tests, PRZM, SESOIL, PESTAN, Solute transport.

At present, most model testing and validation studies must rely on a limited data base of a few field studies designed to collected data for a variety of purposes. This article discusses and summarizes a few selected model testing studies of this type which relied on available field data. These studies demonstrate the types of comparisons that are often made between field data and model predictions, the procedures required for model testing, and the model performance or acceptance criteria (or statistical tests) used to quantify model performance. The remainder of this chapter is based primarily on two recent studies aimed at testing and evaluating these three models: SESOIL, PRZM, and PESTAN. (See also W89-01859) (Lantz-PTT)
W89-01864

SHORT-CUT CHRONIC TOXICITY ESTIMATES USING DAPHNIA MAGNA,
Monsanto Co., St. Louis, MO.
For primary bibliographic entry see Field 5A.
W89-01936

EXTRAPOLATING FROM THE LABORATORY TO THE FIELD: HOW UNCERTAIN ARE YOU,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5C.
W89-01955

ARE THE 'GUIDELINES FOR DERIVING NUMERICAL NATIONAL WATER QUALITY CRITERIA FOR THE PROTECTION OF AQUATIC LIFE AND ITS USES' BASED ON SOUND JUDGMENTS,
Environmental Research Lab.-Duluth, MN.
For primary bibliographic entry see Field 5G.
W89-01962

HOW REPRESENTATIVE ARE THE DATA SETS USED TO DERIVE NATIONAL WATER QUALITY CRITERIA,
EA Engineering, Science, and Technology, Inc., Northbrook, IL. Midwest Regional Office.
For primary bibliographic entry see Field 5G.
W89-01963

AQUATIC HAZARD EVALUATION PRINCIPLES APPLIED TO THE DEVELOPMENT OF WATER QUALITY CRITERIA,
Monsanto Co., St. Louis, MO.
For primary bibliographic entry see Field 5G.
W89-01964

EVALUATION OF A SITE-SPECIFIC WATER QUALITY CRITERION FOR PENTACHLOROPHENOL USING OUTDOOR EXPERIMENTAL STREAMS,
Environmental Research Lab.-Duluth, Monticello, MN. Monticello Ecological Research Station.
For primary bibliographic entry see Field 5G.
W89-01966

USE OF STATISTICAL INFORMATION TO IMPROVE COMPATIBILITY BETWEEN THE VARIOUS COMPONENTS OF THE WATER QUALITY BASED APPROACH,
Environmental Research Lab.-Duluth, MN.
For primary bibliographic entry see Field 5G.
W89-01967

MONTE CARLO METHOD IN RADIOTRACER EXPERIMENTS,
Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania). Tracer Hydrology Lab.
For primary bibliographic entry see Field 2A.
W89-01985

U.S. ENVIRONMENTAL PROTECTION AGENCY RIVER REACH FILE: HYDROLOGIC SEGMENT PLOTS - IDAHO.
Bonneville Power Administration, Portland, OR. Div. of Power Resources Planning.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009951. Price codes: A04 in paper copy, A01 in microfiche. DOE Report No. DOE/BP--735, October 1986. 41p.

Descriptors: *Rivers, *Hydrologic maps, *Hydrologic data, *Idaho, Topographic mapping, Geohydrology.

This report contains maps illustrating the hydrologic subdivisions of rivers in Idaho. These 'segment plots' cover the following regions: Sandpoint, Spokane, Pullman, Grangeville, Banker, Boise, Jordan Valley, Wallace, Hamilton, Elk City, Challis, Hailey, Twin Falls, Dillon, Dubois, Idaho Fall, Pocatello, Ashton, Driggs, and Preston. (Lantz-PTT)
W89-02002

U.S. ENVIRONMENTAL PROTECTION AGENCY RIVER REACH FILE: HYDROLOGIC SEGMENT PLOTS - WASHINGTON.
Bonneville Power Administration, Portland, OR. Div. of Power Resources Planning.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009949. Price codes: A04 in paper copy, A01 in microfiche. DOE Report No. DOE/BP--734, October 1986. 37p.

Descriptors: *Rivers, *Hydrologic maps, *Hydrologic data, *Washington, Topographic mapping, Geohydrology.

This report contains maps illustrating the hydrologic subdivisions of rivers in Washington. These 'segment plots' cover the following regions: Cape

Flattery, Copalis Beach North, Copalis Beach South, Victoria, Seattle, Hoquiam, Vancouver, Concrete, Wenatchee, Yakima, The Dalles, Okanogan, Ritzville, Walla Walla, Pendleton, Sandpoint, Spokane, Pullman. (Lantz-PTT)
W89-02003

U.S. ENVIRONMENTAL PROTECTION AGENCY RIVER REACH FILE: HYDROLOGIC SEGMENT PLOTS - OREGON.
Bonneville Power Administration, Portland, OR. Div. of Power Resources Planning.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009950. Price codes: A04 in paper copy, A01 in microfiche. DOE Report No. DOE/BP--733, October 1986. 41p.

Descriptors: *Rivers, *Hydrologic maps, *Hydrologic data, *Oregon, Topographic mapping, Geohydrology.

This report contains maps illustrating the hydrologic subdivisions of rivers in Oregon. These 'segment plots' cover the following regions: Salem Annex, Coos Bay, Coos Bay South, Hoquiam, Vancouver, Salem, Roseburg, Medford, The Dalles, Bend, Crescent, Klamath Falls, Pendleton, Canyon City, Burns, Adel, Grangeville, Baker, Boise, Jordan Valley. (Lantz-PTT)
W89-02004

U.S. ENVIRONMENTAL PROTECTION AGENCY RIVER REACH FILE: HYDROLOGIC SEGMENT PLOTS - MONTANA.
Bonneville Power Administration, Portland, OR. Div. of Power Resources Planning.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009952. Price codes: A04 in paper copy, A01 in microfiche. DOE Report No. DOE/BP--736, October 1986. 53p.

Descriptors: *Rivers, *Hydrologic maps, *Hydrologic data, *Montana, Topographic mapping, Geohydrology.

This report contains maps illustrating the hydrologic subdivisions of rivers in Montana. These 'segment plots' cover the following regions: Kalispell, Wallace, Hamilton, Elk City, Cut Bank, Choteau, Butte, Dillon, Dubois, Shelby, Great Falls, White Sulphur Springs, Bozeman, Ashton, Havre, Lewistown, Roundup, Billings, Glasgow, Jordan, Forsyth, Hardin, Wolf Point, Glendive, Miles City, Ekalaka. (Lantz-PTT)
W89-02005

CLASSIFYING INDUSTRIAL SLUDGE USING A KNOWLEDGE-BASED EXPERT SYSTEM,
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-02044

METHODOLOGY FOR UTILIZING RESPIROMETRIC DATA TO ASSESS BIODEGRADATION KINETICS,
Delaware Univ., Newark. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-02063

INDEXES FOR ASSESSING FISH BIOMASS AND YIELD IN RESERVOIRS,
Aquatic Ecosystem Analysts, Fayetteville, AR.
R. M. Jenkins.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 175-192, 6 fig, 2 tab, 22 ref.

Descriptors: *Data interpretation, *Biomass, *Fish, *Reservoirs, *Ecological effects, Water pollution effects, Statistical analysis.

Studies of long-term trends in lake fish populations aimed at identifying the superimposed effects of contaminants are very difficult and expensive. Analyses are required for all processes controlling species population size, including pollutants that may be stressing the population. Improved quantitative monitoring methods are needed to establish cause and effect relationships. In the interim, simpler methods of estimating fish biomass and yield are available to provide comparative indexes to 'normal' lake conditions and to aid in identifying perturbed ecosystems. Empirical multiple regression equations derived from analyses of data assembled from reservoirs > 200 ha in the United States are now available for use as assessment indexes. Variables include 23 physicochemical attributes of the environment and angler use and sport fish yield statistics from 380 reservoirs in 26 states. Subsamples of these data sets, sorted by similar water chemistry, operational use, and surface area characteristics, were also analyzed. The regressions derived are not guaranteed to express cause-effect relations but do afford standards for comparison and quantitative predictive values. Until more precise natural lake ecosystem models are developed, it is recommended that analogous data sets, assembled on a drainage basin, regional, national or global basis, be analyzed in a similar manner to provide standards for sorting unstressed, naturally-stressed and contaminant-stressed communities. Such endeavors could help in the development of legally-adequate ecosystem epidemiology. (See also W89-02137) (Author's abstract)
W89-02146

ANALYSIS OF LONG-DURATION PIEZOMETRIC RECORDS FROM BURKINA FASO USED TO DETERMINE AQUIFER RECHARGE,
Bureau de Recherches Geologiques et Minieres, Orleans (France).
For primary bibliographic entry see Field 2F.
W89-02254

PRIMER FOR COMPUTERIZED WASTEWATER APPLICATIONS.
Water Pollution Control Federation, Alexandria, VA. Task Force on Computerized Treatment Plant Application.
For primary bibliographic entry see Field 5D.
W89-02258

8. ENGINEERING WORKS

8A. Structures

HYDRAULIC BARRIERS IN SOIL AND ROCK.
For primary bibliographic entry see Field 8D.
W89-01612

LABORATORY TESTING OF CEMENT-BENTONITE MIX FOR PROPOSED PLASTIC DIAPHRAGM WALL FOR COMPLEXE LA-GRANDE RESERVOIR CANIAPISCAU, JAMES BAY, CANADA,
STS Consultants Ltd., Northbrook, IL.
For primary bibliographic entry see Field 8F.
W89-01618

GROUNDWATER AND WELLS,
For primary bibliographic entry see Field 2F.
W89-01766

OLD RIVER LOW-SILL CONTROL STRUCTURE: DYNAMIC HYDRAULIC FORCES ACTING ON THE STILLING BASIN, SURVEY BOAT SAFETY, AND DEBRIS PASSAGE: HYDRAULIC MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W89-01767

POND CREEK PUMPING STATION, SOUTHWESTERN JEFFERSON COUNTY, KENTUCKY: HYDRAULIC MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8C.
W89-01768

LAKE DARLING SPILLWAY, SOURIS RIVER, NORTH DAKOTA: HYDRAULIC MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
D. R. Cooper.
Available from the National Technical Information Service, Springfield, VA. 22161 as AD-A196 -86. Price codes: A05 in paper copy; A01 in microfiche. Technical Report No. HL-88-9, April 1988. Final Report. 74 p, 11 fig, 6 tab, 6 photos, 41 plates.

Descriptors: *Spillways, *Lake Darling, *Souris River, *North Dakota, *Hydraulic models, Model studies, Hydraulic properties, Channels, Flow profiles, Eddies, Flow control, Riprap, Sluice.

The concrete gravity ogee spillway for the Lake Darling Dam will contain five 22-ft-high by 43-ft-wide gate bays separated by 10-ft-wide piers. Outlet works consisting of four sluices within the piers will discharge into the spillway stilling basin. A hydraulic-jump-type stilling basin will provide satisfactory dissipation of the spillway and sluice flows. A 1:36-scale model of the spillway, sluices, stilling basin, approach area, and exit channel was used to study the overall hydraulic performance of the structure. Tests indicated that flow conditions in the approach to the spillway with both uncontrolled and controlled flows were satisfactory for the full range of anticipated discharges. Eddies developed on either side of the stilling basin. Constricting the channel flare to a uniform width eliminated the eddies. The size and extent of stone protection required on the dam embankment, side slopes and bottom of the approach channel, and side slopes and bottom of the exist channel were determined by model investigations. (Author's abstract)
W89-01769

CINQUE HOMMES, JONES CUTOFF, BOIS BRULE AND MISSOURI CHUTE PUMPING STATIONS; PERRY COUNTY, MISSOURI, AND RANDOLPH COUNTY, ILLINOIS: HYDRAULIC MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W89-01772

WADDELL DAM, MARICOPA COUNTY, ARIZONA: PHOTOGRAPHS; WRITTEN HISTORICAL AND DESCRIPTIVE DATA, REDUCED COPIES OF DRAWINGS,
National Park Service, San Francisco, CA. Historic American Building Survey.
D. M. Introcaso.
HAER No. AZ-11, 1988. 284 p, 153 photos, 97 ref. Contract No. 6-CS-04460.

Descriptors: *History, *Waddell Dam, *Water resources development, Dams, Social aspects, Dam safety, Arizona, Economic aspects.

A written narrative is given of the political and economic events and factors important in the construction of Waddell Dam, located on the Agua Fria River approximately 35 miles northwest of Phoenix, Arizona. The dam was part of the Agua Fria Water Project, a privately funded water resources development project started in 1891. Upon its completion, Waddell Dam (then named Pleasant Dam) was the largest multiple arch dam in the world. In the 1920's the dam was the focus of considerable controversy when cracks were noted in the concrete buttresses prior to filling of the reservoir; it became part of a larger controversy concerning the safety of the multiple arch dam design. Waddell Dam and the Agua Fria Project is the only dam and water project that was successfully completed by private developers in central Arizona. The report also contains historic and current view photographs of the dam and associat-

ed features and persons, and as-built drawings of the dam. (Author's abstract)
W89-01805

FLOOD PROOFING BIBLIOGRAPHY, ANNOTATED.
Soil Conservation Service, Washington, DC.
For primary bibliographic entry see Field 6F.
W89-01807

RED RIVER WATERWAY SEDIMENTATION STUDY DOWNSTREAM FROM LOCK AND DAM NO. 1: NUMERICAL MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2J.
W89-01814

WELL CONSTRUCTION: DRILLING, LOCATION AND SAFETY,
Michigan Dept. of Public Health, Lansing.
D. K. Keech.
IN: Rural Groundwater Contamination. Lewis Publishers, Inc., Chelsea, Michigan, 1987. p 291-301, 1 tab.

Descriptors: *Well construction, *Site selection, *Safety, *Drilling, Irrigation, Grouting, Irrigation, Pump testing, Pump wells, Pumps, Water analysis.

Wells installed in an agricultural community are generally drilled to meet two basic needs; either a well to supply water for drinking and other domestic users at the homestead, or to provide the larger water requirements for irrigation purposes. Any well drilled in the State of Michigan for production of freshwater must meet the well construction rules promulgated by the Michigan Department of Public Health under the authority of the Groundwater Quality Control Act passed in 1965. This statute has now been incorporated into the Michigan Public Health Code as Part 127 of Act 368, P.A. 1978, as amended. These rules cover any freshwater well that is installed, whether it is for drinking water needs, irrigation, or industrial use. Selection of well specifications and drilling procedures, grouting, irrigation wells, well development and pump testing, pump installation, disinfection, and water analysis are discussed. (See also W89-02196) (Lantz-PTT)
W89-02215

DESIGN AND CONSTRUCTION OF WATER WELLS: A GUIDE FOR ENGINEERS,
National Water Well Association, Worthington, OH.
J. Lehr, S. Hurlbut, B. Gallagher, and J. Voytek.
Van Nostrand Reinhold Company, New York. 1988. 229p.

Descriptors: *Water wells, *Well construction, *Design standards, *Construction, *Groundwater, *Geohydrology, Engineers, Aquifers, Pumping tests, Intakes, Groundwater movement.

A need for a basic preparatory text on the nature of water wells, their construction, development, and operation has been widely recognized. The book is intended to fill the void for the professionals new to groundwater and wells, who will be working on projects involving well construction or maintenance. The book begins with a general discussion of groundwater and geology to acquaint the reader with the dynamics and occurrence of groundwater on the earth. Fundamental physical properties pertaining to groundwater flow are introduced in Chapter 2. The engineering-oriented portion of the text then beings with a discussion of the advantages and drawbacks of the different methods of well drilling. A chapter on well design follows, including full details on the concepts and concerns of well design. Chapter 5 is dedicated to intake design, a critical but often misunderstood aspect of every water well. Water well construction techniques are described clearly and concisely in Chapter 6, followed by a thorough description of how a well is developed after construction to maximize its yield. Pumping tests are considered as methods to use wells to analyze aquifer characteristics. Well maintenance and rehabilitation are given significant emphasis in Chapter 9. There is a special section on rock-well construction. (Lantz-PTT)
W89-02256

ANALYSIS OF WATER DISTRIBUTION SYSTEMS,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5F.
W89-02259

8B. Hydraulics

HEAD RECOVERY AT SUBMERGED ABRUPT CONDUIT OUTLETS,
Northwest Hydraulic Consultants Ltd., Edmonton (Alberta).
J. A. Kells, and C. D. Smith.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 2, p 272-274, April 1988. 2 fig, 2 ref.

Descriptors: *Conduits, *Outlets, *Pipes flow, *Open channel flow, *Hydraulics, Head loss, Head recovery, Culverts, Outfall.

The question of an abrupt expansion from one diameter to a larger diameter is a classical problem dealt with in most undergraduate fluid mechanics texts. A problem not dealt with, but which is far more common in practice, is the abrupt expansion at the terminal end of a pipe where the flow expands into an open channel downstream. It is often assumed that the entire velocity head for the pipe plow is lost. This is not necessarily true. An experimental study of an abrupt expansion into an open channel is reported. Several different channel shapes are used in an attempt to determine shape effect, if any. It is concluded that the primary variable affecting the head loss is the ratio of the upstream to downstream flow area, called the area ratio. (Author's abstract)
W89-01340

PRACTICAL EXPERIENCE OF BOREHOLE PERFORMANCE EVALUATION,
For primary bibliographic entry see Field 5F.
W89-01356

MODELLING LONG AND INTERMEDIATE WAVES IN A HARBOR,
Tetra Tech, Inc., Pasadena, CA.
W.-L. Chiang.
Applied Mathematical Modelling AMMODL, Vol. 12, No. 4, p 423-428, August 1988. 9 fig, 13 ref. Port of Long Beach, CA Contract No. HD-3864.

Descriptors: *Hydraulic models, *Model studies, *Waves, *Harbors, *Mathematical models, Landfills, Dredging, Finite difference methods, Basins, Channels, Wave height, Numerical analysis, Hydrodynamics, Mathematical equations, Boundary conditions, Los Angeles Harbor, Long Beach Harbor, California.

A transient model is utilized to study the effect of the proposed 2010/2020 master plan on wave conditions in Los Angeles and Long Beach harbors. The proposed plan consists of placing landfills and increasing basin and channel depths. The numerical model incorporates an implicit, finite-difference scheme to solve a set of hydrodynamic equations with a two-dimensional depth-averaged formulation. Long-wave equations are slightly revised such that the model can be applied to wave propagation in intermediate depths. The wave period under consideration ranges from 30 to 300 s. A base run was performed to study existing conditions. The results are compared with laboratory measurements. Although there is a slight discrepancy in the results, partially due to the different boundary conditions in the models, the general pattern and order of magnitude of the spectrum fit reasonably well with laboratory results. The numerical model is applied to the proposed 2010/2020 master plan to obtain spectra of relative wave height at a location of interest. Resonance appears at a wave period of 203 s. A contour map of relative maximum wave height is presented. (Author's abstract)
W89-01362

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART I,
For primary bibliographic entry see Field 2E.
W89-01412

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART II,
For primary bibliographic entry see Field 2E.
W89-01413

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART IV,
For primary bibliographic entry see Field 7B.
W89-01415

TURBULENCE MODELING OF SURFACE WATER FLOW AND TRANSPORT: PART V,
For primary bibliographic entry see Field 2E.
W89-01416

MODELING TURBULENT TRANSPORT IN STRATIFIED ESTUARY,
Hanover Univ. (Germany, F.R.). Inst. fuer Stroemungsmaschinen.
For primary bibliographic entry see Field 5B.
W89-01419

GROUNDWATER AND WELLS,
For primary bibliographic entry see Field 2F.
W89-01766

OLD RIVER LOW-SILL CONTROL STRUCTURE: DYNAMIC HYDRAULIC FORCES ACTING ON THE STILLING BASIN, SURVEY BOAT SAFETY, AND DEBRIS PASSAGE: HYDRAULIC MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
B. P. Fletcher.
Available from the National Technical Information Service, Springfield, VA. 22161 as AD-A194 306. Price codes: A04 in paper copy; A01 in microfiche. Technical Report No. HL-88-6, April 1988. Final Report. 62p, 11 fig, 5 tab, 33 photos, 10 plates.

Descriptors: *Hydraulic models, *Hydraulic properties, *Old River, *MIssissippi River, *Stilling basins, *Louisiana, Navigation, Baffles, Fluid mechanics, Hydraulic profiles, Gates, Debris passage.

Tests were conducted in 1:36-scale section models of the high and low bays to develop guidance for rehabilitation of the existing stilling basin, to develop guidance for the safety of survey boats operating in the approach to the structure, and to evaluate characteristics of debris passage through the structure. The portion of the basin between the baffles and end sill was protected with sloping modules constructed of steel and grout, and tests were conducted to determine the hydraulic forces acting on the modules. A flow spoiler design to reduce uplift forces on the modules and not increase the sliding and uplift forces acting on the stilling basin was also investigated. Survey boat safety tests indicated that a typical survey boat operating upstream of the gate bays should be safe with gate openings < or = 30% of the head on the crest. Debris passage tests indicated that debris up to 35 ft long and 3.0 ft thick would pass through the structure with gate openings > or = to 30 to 40% of the head on the crest. (Author's abstract)
W89-01767

LAKE DARLING SPILLWAY, SOURIS RIVER, NORTH DAKOTA: HYDRAULIC MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station,

Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8A.
W89-01769

CINQUE HOMMES, JONES CUTOFF, BOIS BRULE AND MISSOURI CHUTE PUMPING STATIONS; PERRY COUNTY, MISSOURI, AND RANDOLPH COUNTY, ILLINOIS: HYDRAULIC MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
B. P. Fletcher.
Available from the National Technical Information Service, Springfield, VA. 22161 as AD-A197 699. Price codes: A05 in paper copy; A01 in microfiche. Technical Report No. HL-88-13, June 1988. Final Report. 91p, 10 fig, 5 tab, 20 photos, 31 plates.

Descriptors: *Cinque Hommes, *Jones Cutoff, *Bois Brule, *Missouri, *Pumping plants, *Illinois, *Hydraulic models, *Flow profiles, Hydraulic properties, Model studies, Channel flow, Outlets, Riprap.

The four pumping stations (Cinque Hommes, Jones Cutoff, Bois Brule, and Missouri Chute) provide flood protection for about 26,800 acres of highly productive bottomland. Satisfactory hydraulic performance was obtained in the sumps for the Cinque Hommes and Jones Cutoff pumping stations by either extending wing walls from each side of the structures or by moving the timber trashrack closer to the sump and enclosing the rear and sides of the sump. Following the model studies of the sumps for Cinque Hommes and Jones Cutoff pumping stations, the design of the sump and trashrack for the Bois Brule pumping station was revised due to the high cost of building and maintaining the timber trashrack. The revised design, consisting of a classical trashrack and free-standing side and rear walls, performed satisfactorily. The model of the Missouri Chute sump indicated unsatisfactory flow due to adverse currents in the sump generated by lateral flow from a side channel located normal to the main channel. The mouth of the side channel was relocated farther upstream and satisfactory performance was obtained. The designs of the 45-deg saxophone outlets and channel configurations for the four pumping stations were similar. Design guidance for the size and extent of riprap needed in the exit channels was determined from the models. (Author's abstract)
W89-01772

RED RIVER WATERWAY SEDIMENTATION STUDY DOWNSTREAM FROM LOCK AND DAM NO. 1: NUMERICAL MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2J.
W89-01814

ANALYSIS OF WATER DISTRIBUTION SYSTEMS,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5F.
W89-02259

8C. Hydraulic Machinery

DESIGN AND CONSTRUCTION OF THE ISLE OF DOGS PUMPING STATION,
Halcrow (William) and Partners, London (England).
For primary bibliographic entry see Field 5D.
W89-01355

FOUNDATION TREATMENT IN KARSTIC LIMESTONE: EL CAJON HYDROELECTRIC PROJECT, HONDURAS,
Merritt (A.H.), Gainesville, FL.
For primary bibliographic entry see Field 8E.
W89-01364

THREE LOW COST PUMPING SYSTEMS FOR HYDROCARBON CONTAMINATED GROUND WATER,
Geoscience Consultants Ltd., Albuquerque, NM.
For primary bibliographic entry see Field 5G.
W89-01534

PRACTICAL APPROACH TO HYDROCARBON RECOVERY AT MARINE TERMINALS,
Engineering Enterprises, Inc., Long Beach, CA.
For primary bibliographic entry see Field 5G.
W89-01536

MECHANICAL INTEGRITY OF CLASS 1 INJECTION WELLS,
Texas World Operations, Inc., Houston, TX.
For primary bibliographic entry see Field 5E.
W89-01567

CEMENTING TO ACHIEVE ZONE ISOLATION,
Haliburton Services, Duncan, OK.
For primary bibliographic entry see Field 5E.
W89-01568

INDUSTRIAL WASTE DISPOSAL WELLS: MECHANICAL INTEGRITY,
Texas Water Commission, Austin.
For primary bibliographic entry see Field 5E.
W89-01569

CLASS I INJECTION WELL DESIGN CONSIDERATIONS: USING FIBERGLASS TUBULARS AND EPOXY CEMENT,
Du Pont de Nemours (E.I.) and Co., Beaumont, TX.
J. R. Creech.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 113-132, 8 fig, 1 tab, 1 ref.

Descriptors: *Injection wells, *Well casings, *Disposal wells, *Design criteria, *Cements, Waste disposal, Liquid wastes, Portland cements, Sealants, Corrosion, Deep wells, Epoxy resins, Plastics.

A Class I Injection Well is used to transport liquid wastes thousands of feet into the earth to a point where it will remain safely entombed. A sound well design requires the use of extensively engineered plans, much of which depends to a large extent on choosing materials of construction and cement that are corrosively resistant to the injected waste fluids. Materials and cement play an important role in providing the needed mechanical structure and integrity for the injection well as the delivery system component of underground injection technology. No single material is available that is universally resistant to all types of waste fluids. It is important to match well materials to the injection stream for each injection well application. For some wastes, the ferrous and nonferrous metals or portland cements commonly used in deep well construction may not offer the desired corrosion resistance. Two materials, fiber-reinforced thermoset plastics (FRP) and epoxy resin cement, which have been particularly useful in solving these corrosion resistance problems are discussed. Properly selected materials of construction for a Class I Injection Well help to minimize corrosion, reduce maintenance and repairs, provide for smooth and reliable operations, and ensure a sound well design that will operate safely and provide the needed protection of the environment. (See also W89-01564) (Author's abstract)
W89-01570

TESTING AND REPAIR OF A LEAKING DEEP INJECTION WELL,
CH2M Hill, Inc., Gainesville, FL.
For primary bibliographic entry see Field 5E.
W89-01571

FACTORS EFFECTING THE AREA OF REVIEW FOR HAZARDOUS WASTE DISPOSAL WELLS,
Davis (Ken E.) Associates, Houston, TX.
For primary bibliographic entry see Field 5E.
W89-01572

FLUID SEALED CLASS I INJECTION WELLS,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
C. R. Sherman, and P. L. Craig.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 195-210, 11 fig.

Descriptors: *Deep wells, *Sealants, *Well casings, Disposal wells, Monitoring, Liquid wastes, Testing procedures.

The proper and safe operation of Class I industrial injection wells requires a method to isolate waste from the space between the injection tubing and the protection casing or annulus space. Fluid in the annulus acts as a pressure transmitter that, through monitoring, will alert an operator to a leak in the tubing, protection casing, or wellhead. At the ground surface, a wellhead is attached to the top of the protection casing. The protection casing extends to or through the injection zone and is usually composed of carbon steel and a waste resistant material at the bottom. The protection casing is cemented to the borehole. The injection tubing which is used to convey waste from the surface down to the injection zone is composed of waste resistant material. At the surface there are a number of facilities integral to the operation of a fluid sealed system, including annulus fluid storage tanks, pressure maintenance facilities, and monitoring instrumentation. The pressure within the injection tubing must be less than the annulus pressure. Annulus pressure monitoring is done by a manometer. An example of an operating fluid sealed system is given. The most critical factors to be considered when designing and operating a fluid sealed system are the fluid densities and temperatures. (See also W89-01564) (Author's abstract)
W89-01573

INTEGRITY TESTING OF CLASS I HAZARDOUS INJECTION WELLS: RELATED EXPERIENCE IN THE GREAT LAKES REGION,
Davis (Ken E.) Associates, Houston, TX.
For primary bibliographic entry see Field 5E.
W89-01574

MECHANICAL INTEGRITY RESEARCH,
Robert S. Kerr Environmental Research Lab., Ada, OK.
J. T. Thornhill, and B. G. Benefield.
IN: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes. National Water Well Association, Dublin, OH. 1986. p 241-278, 13 fig.

Descriptors: *Logging, (Recording), *Injection wells, *Well casings, *Test wells, *Injection wells, *Disposal wells, Waste disposal, Testing procedures, Mechanical failure, Leakage, Groundwater pollution, Well logs.

Underground injection control regulations of the U.S. Environmental Protection agency require that all injection wells demonstrate mechanical integrity, which is defined as no significant leak in the casing, tubing or packer; and no significant fluid movement into an underground source of drinking water through vertical channels adjacent to the injection well bore. Two test wells were constructed for mechanical integrity testing; a logging well to test for channels in the cement behind the casing and a leak test well for developing methods for testing the integrity of the tubing, casing and packer as well a locating fluid movement in channels behind the casing. Channels were built into the logging well covering 90, 60, 30, and 6 degrees of the 360 degree circle described by the casing. Two generations of logging tools have been run in the logging well; the cement bond tool and the cement evaluation tool. There are various transmitter/receiver combinations available for the cement bond tool. The transmitter/receiver that provides

the most information is a single transmitter with dual receivers spaced three feet and five feet from the transmitter. The second generation tools consist of a tool having eight ultrasonic transducers spiraled around it to survey the circumference of the casing. None of the logging tools presently available located any of the 6 degree channels. The second generation tools located all of the 30, 60, and 90 degree channels and a calibrated cement bond tool with dual receiver three foot/five foot spacing located all but one of the 30 degree and all of the 60 and 90 degree channels. The tools must be calibrated prior to their use and industry is encouraged to continue research to increase the sensitivity of the tools for mechanical integrity determinations. (See also W89-01564) (Author's abstract)
W89-01575

OPERATION AND MAINTENANCE OF UNDERGROUND INJECTION WELLS,
Du Pont de Nemours (E.I.) and Co., Victoria, TX.
For primary bibliographic entry see Field 5E.
W89-01578

CONCEPTUAL FRAMEWORK TO GUIDE AQUATIC MONITORING PROGRAM DESIGN FOR THERMAL ELECTRIC POWER PLANTS,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W89-01606

POND CREEK PUMPING STATION, SOUTHWESTERN JEFFERSON COUNTY, KENTUCKY: HYDRAULIC MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
B. P. Fletcher.
Available from the National Technical Information Service, Springfield, VA. 22161 as AD-A194 387. Price codes: A05 in paper copy; A01 in micrfoiche. Technical Report No. HL-88-7, April 1988. Final Report. 96 p, 24 fig, 6 tab, 15 photos, 33 plates.

Descriptors: *Pond Creek, *Kentucky, *Hydraulic models, *Hydraulic machinery, *Pumping plants, Baffles, Stilling basins, Hydraulic properties, Open channels, Flow profiles, Vortices, Gravity flow.

A 1:20-scale pumping station model of the sump and gravity control, approach, stilling basin, and exit channel was used to investigate and develop a practical design that would provide satisfactory hydraulic performance. The pumping station and gravity control structures were combined by locating the gravity control below the sump. The pumping station consisted of four vertical pumps with a total capacity of 4,100 cfs. The gravity control section had a capacity for 17,000 cfs and consisted of an open-channel flow structure and tainter gate to maintain the pool. During operation of the pumps, surface vortices observed in the pump bays were eliminated by surface vortex suppressor beams. During operation of the gravity control structure, eddies and an unstable hydraulic jump observed in the stilling basin were eliminated by decreasing the rate of sidewall flare and strategically locating and increasing the height of the baffle blocks. (Author's abstract)
W89-01768

PRIME MOVERS ENGINES, MOTORS, TURBINES, PUMPS, BLOWERS AND GENERATORS.
Water Pollution Control Federation, Alexandria, VA.
Manual of Practice No. OM-5. Water Pollution Control Federation, Washington, DC. 1984. 181p.

Descriptors: *Hydraulic machinery, *Wastewater facilities, Pumps, Blowers, Engines, Turbines, Electric generators, Wastewater treatment, Design criteria.

This Manual of Practice draws together information on pumps, blowers, electric motors, and engines as the prime movers of the wastewater treatment industry. In addition, turbines and electric generators are included to round out the list of available choices of prime movers. With nine possible combinations of these machines, their relative advantages, disadvantages, and application idiosyncrasies are of critical importance to anyone involved in operations, maintenance, or design of a wastewater treatment facility. (Lantz-PTT)
W89-01821

AQUATIC BIOLOGY AND HYDROELECTRIC POWER DEVELOPMENT IN NEW ZEALAND.
For primary bibliographic entry see Field 6G.
W89-01871

LOCAL (SMALL-SCALE) HYDROELECTRIC RESOURCES,
Ministry of Works and Development, Wellington (New Zealand).
For primary bibliographic entry see Field 6A.
W89-01873

SUBMISSIONS, RECOMMENDATIONS AND OBJECTIONS: THE NATURE CONSERVATION COUNCIL'S EXPERIENCE,
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
For primary bibliographic entry see Field 6E.
W89-01878

8D. Soil Mechanics

HYDROLOGIC FACTORS TRIGGERING A SHALLOW HILLSLOPE FAILURE,
California Univ., Santa Cruz. Dept. of Earth Sciences.
For primary bibliographic entry see Field 2G.
W89-01363

HYDRAULIC BARRIERS IN SOIL AND ROCK.
American Society for Testing and Materials, Philadelphia, PA. A symposium sponsored by ASTM Committee D18 on Soil and Rock in cooperation with the United States Committee on Large Dams of the International Commission on Large Dams, Denver, CO, 25 June 1984. ASTM Special Technical Publication 874. ASTM Publication Code Number 04-874000-38. 1985. 332p.

Descriptors: *Cutoff walls, *Symposium, *Liners, Soil mechanics, Bentonite, Clays, *Soil properties, Hydraulic permeability, Waste disposal, Waste dumps, Landfills, Permeameters, Kaolinite, Cements, Fly ash, Permeability coefficient, Pore size, Brines, Leachates.

The ASTM Committee D18, through its Subcommittee D18.20 and in cooperation with the U.S. Committee on Large Dams of the International Commission on Large Dams, organized a one-day symposium on impermeable barriers, held 25 June 1984 in Denver, Colorado. The symposium consisted of two half-day sessions - the first on slurry walls and the second on clay and soil-admix liners. The seven papers contained in the first part of the publication present some of the latest innovations and advancements in slurry wall technology from design aspects through construction and testing methodology. The papers discuss soil-bentonite walls, cement-bentonite walls, composite walls of clay and high-density polyethylene sheeting, and grouted walls constructed by use of the vibrating beam technique. One paper also compares the conventional slurry wall construction to the vibrating team technique. The afternoon session of the symposium was primarily concerned with clay and soil-admix liners used as hydraulic barriers. Of the fourteen papers presented in the latter part of this publication, four were originally presented in briefer form as posters. The papers presented herein describe a variety of laboratory studies and case histories including the following: direct evaluation of permeability tests utilizing both fixed-wall and flexible-wall permeameters; a proposed field permeability test procedure using a large diameter covered ring; an overview on the construction, testing, and research for soil-cement liners; and the potential use of fly ash in reducing the permeability of otherwise permeable soil liners. Other papers examined factors that affect desiccation cracking of compacted soil and clay liners, the effects of brine on an earth lining, and various other case histories on permeant effects on clay linings. (See W89-01613 thru W89-01633) (Geiger-PTT)
W89-01612

SLURRY CUTOFF WALLS: APPLICATIONS IN THE CONTROL OF HAZARDOUS WASTES,
Geo-Con, Inc., Pittsburgh, PA.
For primary bibliographic entry see Field 5G.
W89-01613

SUBSURFACE POLLUTION CONTAINMENT USING A COMPOSITE SYSTEM VERTICAL CUTOFF BARRIER,
Wehran Engineering Corp., Middletown, NY.
For primary bibliographic entry see Field 5G.
W89-01614

THIN SLURRY CUTOFF WALLS INSTALLED BY THE VIBRATED BEAM METHOD,
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-01615

EVALUATION OF TWO METHODS FOR CONSTRUCTING VERTICAL CUTOFF WALLS AT WASTE CONTAINMENT SITES,
American Colloid Co., Skokie, IL.
For primary bibliographic entry see Field 5G.
W89-01616

INFLUENCE OF INORGANIC PERMEANTS UPON THE PERMEABILITY OF BENTONITE,
International Minerals and Chemical Corp., Detroit, MI.
For primary bibliographic entry see Field 5G.
W89-01617

EFFECTS OF VARIOUS LIQUIDS ON CLAY SOIL: BENTONITE SLURRY MIXTURES,
Brown (K.W.) and Associates, Inc., College Station, TX.
D. C. Anderson, W. Crawley, and J. D. Zabcik.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 93-103, 5 fig, 2 tab, 11 ref.

Descriptors: *Bentonite, *Slurries, *Clays, *Permeability, *Cutoff walls, *Slurry walls, Methanol, Permeameters, Leachates, Seepage control, Backfill, Calcium sulfate.

Slurry-wall backfill materials were placed in double-ring permeameters to evaluate their permeability to water, xylene, and methanol. Permeability determinations were made using double-ring permeameters because these devices separate flow that occurs near the sidewalls from flow occurring through the central portion of the specimens. The use of double-ring devices appears to overcome some of the limitations of fixed-wall and flexible-wall permeameters. Fixed-wall devices may have sidewall flow, and flexible-wall devices may be inappropriate for testing soft specimens such as a slurry mixture. permeability tests on materials that are to contain waste leachates are typically done using water containing 0.01 N calcium sulfate ($CaSO_4$) as the permeant liquid. The results of this study show that permeability values determined with water may be misleading. Low permeabilities were obtained with water, but both xylene and methanol caused large permeability increases in the soil-slurry mixtures. (See also W89-01612) (Author's abstract)
W89-01619

FIXED-WALL VERSUS FLEXIBLE-WALL PERMEAMETERS,
Texas Univ., Austin. Dept. of Civil Engineering.

For primary bibliographic entry see Field 7B.
W89-01620

PERMEABILITY OF CLAY TO ACIDIC AND CAUSTIC PERMEANTS,
Missouri Univ., Rolla.
For primary bibliographic entry see Field 5B.
W89-01621

PERMEABILITY TESTING ON CLAYEY SOIL AND SILTY SAND-BENTONITE MIXTURE USING ACID LIQUOR,
Woodward-Clyde Consultants, Englewood, CO.
A. H. Gipson.
IN: Hydraulic Barriers in Soil and Rock. American Society for testing and Materials, Philadelphia, PA. 1985. p 140-154, 7 fig, 9 tab, 2 ref.

Descriptors: *Liners, *Clays, *Soil sealants, *Permeability, Acids, Seepage control, Silt, Soil properties, Sand, Bentonite.

A laboratory permeability testing program was designed and performed to evaluate the effect of an acid liquor on two alternative materials planned for use in a compacted soil lining to minimize seepage loses from a phosphogypsum storage area. The alternative materials considered for use in the compacted soil lining included (1) on-site natural clayey soils and (2) on-site silty sands mixed with commercial bentonite (Volclay saline seal, No. 100). The acid liquor has a pH of 2.2 and is high in calcium, calcium oxides, sodium, chloride, and sulfate. The test results indicated that the acid liquor permeant resulted in lower permeabilities of the clayey soils than with tap water permeant. The tests on the commercial bentonite-silty sand mixtures with acid liquor permeant indicated that the permeability increased with time. (See also W89-01612) (Author's abstract)
W89-01622

PROCEDURE AND EQUIPMENT FACTORS AFFECTING PERMEABILITY TESTING OF A BENTONITE-SAND LINER MATERIAL,
Wisconsin Univ.-Madison. Dept. of Civil and Environmental Engineering.
T. B. Edil, and A. E. Erickson.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 155-170, 7 fig, 3 tab, 8 ref.

Descriptors: *Testing procedures, *Liners, *Permeability, *Bentonite, *Clays, *Sand, Linings, Permeameters, Soil mechanics, Soil properties, Hydraulic gradient.

The effects of procedural and equipment factors on the laboratory measurement of permeability of a bentonite-sand liner were investigated. In the experimental program, permeability tests were performed on compacted specimens of a bentonite-sand mixture to study the effect of (1) permeameter type (rigid-versus flexible-wall permeameters), (2) back pressure application, and (3) hydraulic gradient magnitude on the measured permeabilities. The liner material used in the tests was a mixture of 90% P20-R30 Ottawa sand and 10% bentonite clay. Water was used to prepare the specimens and as the permeant. Specimens were prepared by compaction at moisture contents exceeding optimum using the standard proctor method. A pressure of 380 kPa was used in the tests involving back pressure. The low and high hydraulic gradients used were nominally 29 and 290, respectively. Prior to the termination of a test, a red indicator was passed through the permeameters under the high gradient. The specimens were dissected and inspected after the test for the identification of flow areas and channels. The test results indicated that specimens continue to hydrate during permeation. Unless wetter specimens are used, this continuing hydration interferes with the inflow-outflow balance, depriving the tester of an important check for leaks. Differential hydration throughout the specimen results in different soil structures and zones of flow. For instance, most of the flow may take place in an annular area surrounding a less hydrated core in the center. Since the total cross-sectional area is used in computing the coefficient of permeability, the values may be underestimated. Back pressure, often used to enhance saturation during testing, appears to have a detrimental effect when applied in the rigid-wall permeameters by increasing the potential for formation of channels and side flow. Test results are affected by hydraulic gradient in different ways depending on the type of permeameter. While gradients as high as 360 did not induce piping in the gap-graded liner material tested, the application of very high gradients to accelerate testing is not desirable for a number of other effects observed. (See also W89-01612) (Author's abstract)
W89-01623

EFFECT OF ORGANIC FLUIDS ON HYDRAULIC CONDUCTIVITY OF COMPACTED KAOLINITE,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
Y. B. Acar, A. Hamidon, S. D. Field, and L. Scott.
IN: Hydraulic Barriers in Soil and Rock. American Society for testing and Materials, Philadelphia, PA. 1985. p 171-187, 10 fig, 4 tab, 27 ref. U.S. EPA Cooperative Agreement CR 809714010.

Descriptors: *Hydraulic conductivity, *Liners, *Kaolinite, *Permeability, *Benzenes, *Organic solvents, Phenols, Clays, Soil porosity, Permeameters, Leakage, Testing procedures.

The effects of four organic fluids on hydraulic conductivity of compacted kaolinite are presented. Permeation fluids were 0.1 and 100% solutions of nitrobenzene, acetone, phenol, and benzene, which represent a wide range of dielectric constants. Full saturation hydraulic conductivities were obtained in flexible wall permeameters under continuous back pressure, at hydraulic gradients of less than 100 and effective stresses of calcium sulfate ($CaSO_4$) solution. The effect of the testing scheme was evaluated by measuring the hydraulic conductivity of acetone in both a flexible wall permeameter at variable effective stresses and in a rigid wall permeameter. Dramatic hydraulic conductivity increases were observed in rigid wall permeameters. The results indicate that increases in the hydraulic conductivity measured in rigid wall permeameters can only be explained by side leakages due to shrinkage of the specimen. All tests with chemicals at low concentrations resulted in slight decreases of hydraulic conductivity. Hydraulic conductivity with pure solutions slightly increased with acetone and phenol and significantly decreased with benzene and nitrobenzene. Diffusion through the cell membrane was found to be a considerable source of error in assessing the full strength of organic fluids. The direction of variations in the liquid limit and the free swell of kaolinite with organic fluids was observed to be inversely related to changes in absolute values of hydraulic conductivity at low effective stresses. These results together with fabric studies indicated that changes in hydraulic conductivity with organic fluids can be explained by the variations in the surface forces of interaction on clay particles affecting the flow characteristics. (See also W89-01612) (Author's abstract)
W89-01624

LABORATORY COMPARISON OF THE EFFECTS OF WATER AND WASTE LEACHATE ON THE PERFORMANCE OF SOIL LINERS,
Radian Corp., Austin, TX.
A. G. Eklund.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 188-202, 2 fig, 3 tab, 5 ref.

Descriptors: *Liners, *Hydraulic conductivity, *Leachates, *Permeability, *Pulp wastes, Waste disposal, Seepage control, Landfills, Linings, Soil properties, Soil compaction, Permeability.

A study was conducted to determine the performance of two compacted native soils and the soils plus a commercial additive when exposed to specific paper mill waste leachates. Fluids produced from actual paper mill wastes were used in accelerated (high-pressure), anaerobic permeability tests with two disposal site soils and the soils with a beneficient added. Comparison tests measuring hydraulic conductivity were performed to determine behavioral differences of the candidate soil liners with the waste leachate and water. Test results were used to evaluate waste impacts on soil and on the soil plus a commercial additive. Emphasis was placed on identifying fatal flows in expected field liner performance. Test results indicated that the two soils tested were effective in containing the paper mill waste leachates. One soil physically contained the waste leachates by providing an impermeable barrier (K = << 10 to the minus 7th power cm/second). The other soil, while not providing as strong a physical barrier, (K = 10 to the minus 7th power cm/second), did contain the leachate through chemical attenuation of the trace contaminants in the leachate. While the commercial additive improved the impervious barrier characteristics of this soil, it was determined to be optional. Both mechanisms of containment will be effective in providing protection of groundwater resources below a nonhazardous waste landfill. (See also W89-01612) (Author's abstract)
W89-01625

EFFECT OF ORGANIC FLUIDS ON THE PORE SIZE DISTRIBUTION OF COMPACTED KAOLINITE,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
Y. B. Acar, I. Olivieri, and S. D. Field.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 203-212, 5 fig, 3 tab, 17 ref. U.S. EPA Cooperative Agreement CR 809714010.

Descriptors: *Liners, *Hydraulic conductivity, *Pore size, *Kaolinite, *Organic solvents, *Soil compaction, *Permeability, Benzenes, Phenols, Soil properties, Soil structure, Electrical properties, Seepage control, Leaching.

Permeating organic fluids through compacted kaolinite does not significantly change the distribution of different pore sizes. The mercury intrusion method was used to quantify the pore size and frequency distribution of specimens before and after permeation with nitrobenzene, acetone, phenol, and benzene. Porosity quantification parameters obtained from available hydraulic conductivity models were then correlated with experimental values of absolute permeability. Acetone and phenol resulted in changes of absolute hydraulic conductivity within one order of magnitude, that of 0.01 N calcium sulfate ($CaSO_4$) solution, while benzene and nitrobenzene led to a decrease of two orders of magnitude. Mercury intrusion tests on all specimens indicated that the size and distribution of pores within the 0.008 to 10 micron range were not significantly changed. The conclusion is that changes in hydraulic conductivity of compacted kaolinite are not due to a redistribution of pore sizes due to changes in forces of interaction. The results suggest that the decrease in hydraulic conductivity with benzene and nitrobenzene are due to the low solubility of these chemicals in water. (See also W89-01612) (Author's abstract)
W89-01626

EFFECTS OF BRINE ON THE SOIL LINING OF AN EVAPORATION POND,
Bureau of Reclamation, Denver, CO.
For primary bibliographic entry see Field 5B.
W89-01627

INTERACTIONS BETWEEN ACIDIC SOLUTIONS AND CLAY LINERS: PERMEABILITY AND NEUTRALIZATION,
Battelle Pacific Northwest Labs., Richland, WA.
S. R. Peterson, and G. W. Gee.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 229-245, 7 fig, 3 tab, 17 ref.

Descriptors: *Liners, *Acids, *Clays, *Permeability, *Uranium, *Water pollution sources, Neutralization, Seepage control, Soil properties, Hydrogen ion concentration, Particle size, Leaching, Permeameters, Linings.

Liner failure, defined as an increase in liner permeability, was not found to be a problem when acidic uranium mill tailings solutions percolated through clay liner materials for periods extending up to three years. Liner materials taken from mill sites in Wyoming decreased in permeability with time in the laboratory columns when permeated with tailings solutions. One clay liner decreased in permeability from one half to over two orders of magnitude, depending on the given clay sample and contacting solution. These decreases in permeability were attributed to pore plugging resulting from the precipitation of minerals and solids and to soil particle dispersion. The clay liner material from Morton Ranch, Wyoming, exhibited a residual buffering capacity that was able to maintain column effluent pH values at higher levels than the influent pH values for extended time (in excess of 30 pore volumes). A likely cause for the elevated pH is the redissolution of iron and aluminum hydrous oxides. Redissolution of iron and aluminum hydrous oxides consumes hydrogen ions. (See also W89-01612) (Author's abstract)
W89-01628

DESIGN AND TESTING OF A COMPACTED CLAY BARRIER LAYER TO LIMIT PERCOLATION THROUGH LANDFILL COVERS,
Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-01629

DESICCATION CRACKING OF SOIL BARRIERS,
Hart Crowser, Inc., Seattle, WA.
For primary bibliographic entry see Field 5B.
W89-01630

FIELD PERMEABILITY TEST FOR CLAY LINERS,
Geo-Con, Inc., Pittsburgh, PA.
For primary bibliographic entry see Field 7B.
W89-01631

PERMEABILITY OF FLY ASH AND FLY ASH-SAND MIXTURES,
Wisconsin Power and Light Co., Madison, WI.
For primary bibliographic entry see Field 5G.
W89-01632

SOIL-CEMENT LINERS,
Portland Cement Association, Skokie, IL. Energy and Water Resources Dept.
W. S. Adaska.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 299-313, 9 fig, 16 ref.

Descriptors: *Cements, *Liners, *Permeability, *Fly ash, Hazardous wastes, Wastewater lagoons, Waste disposal, Performance evaluation, Industrial wastes, Reservoir linings, Landfills, Soil mechanics, Soil properties, Linings.

For over 30 years soil-cement has been effectively used to line lakes, reservoirs, ditches, and irrigation ponds. More recently, wastewater treatment lagoons, sludge drying and ash settling ponds, and coal storage areas have been lined with soil-cement. In addition to its low permeability, soil-cement also provides a reliable method of slope protection. Numerous laboratory permeability tests have been performed on various soil-cement mixtures. One study included the addition of lime and fly ash to the mixture. Research has also been conducted on shrinkage cracking in soil-cement and its effect on total seepage. A large-scale field test to determine seepage through a stairstep constructed soil-cement facing was conducted by the Bureau of Reclamation at the Lubbock Regulating Reservoir in Texas. The study indicated the soil-cement to be quite impervious and that most of the seepage occurred through either shrinkage cracks or along the horizontal contact planes. It also showed an overall decrease in seepage with time. The U.S. Environmental Protection Agency (EPA) has reported laboratory test results on the compatibility of soil-cement to various hazardous and other industrial wastes. The tests concluded that exposure to acids such as from electroplating sludges and acidic steel-pickling wastes should be avoided; however, for toxic pesticide formations, oil refinery sludge, toxic pharmaceutical wastes, and rubber and plastic wastes, soil-cement should perform satisfactorily. For caustic petroleum sludges, compatibility tests should be conducted on the specific combination of soil-cement and waste. Basic information on soil-cement as a liner material research work on permeability and compatibility testing are presented. The design, construction, and performance of some unique soil-cement-lined projects also presented as well as information on a new composite soil-cement/synthetic membrane liner system that meets the latest U.S. EPA requirements for containing hazardous wastes. (See also W89-01612) (Author's abstract)
W89-01633

EFFECT OF PORE FLUID PH ON THE DYNAMIC SHEAR MODULUS OF CLAY,
Lehigh Univ., Bethlehem, PA. Environmental Geotechnology Lab.
B. L. Du, G. K. Mikroudis, and H.-Y. Fang.
IN: Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume. American Society for Testing and Materials, Philadelphia, PA. 1986. p 226-239, 11 fig, 3 tab, 7 ref.

Descriptors: *Soil properties, *Soil mechanics, *Clays, *Soil porosity, Shear tests, Sand, Physicochemical properties, Waste disposal, Clay minerals, Kaolinite, Bentonite, Graphical methods, Hydrogen ion concentration.

Laboratory test results on the dynamic shear modulus of clay mineral mixture with sand under dynamic torsion loading are presented. Various pore fluids, as reflected by pH values ranging from 2.0 to 12.0, were introduced in the soil mixtures. Both shear modulus and maximum shear modulus were computed. Consolidation pressures varying from 34.5 to 276 kPa were used. The influence of different pore fluids on the dynamic behavior of a sand clay mixture was examined with two groups of sand-kaolinite and sand/bentonite mixtures. For an acidic fluid (pH < 7): (1) with samples made of kaolinite and sand, the dynamic shear modulus increases when the pH value decreases from pH $=$ 7 and (2) with samples made of bentonite and sand, they dynamic shear modulus decreases when the pH value decreases from pH $= 7$. For an alkaline fluid (pH > 7), the dynamic shear modulus increases initially, but then decreases when the pH value decrases. In the range of pH $= 4$ to 10 the damping ratio of kalolinite and sand remains roughly unchanged: if the pH value is beyond this range the ratio will decrease. It is possible to explain with present theories an increase in the shear modulus with decreasing pH because of more flocculated clay strucutre or a decrease in teh shear modulus with increasing pH caused by a more dispersed clay structure. (See also W89-01634) (Author's abstract)
W89-01647

CASE STUDY OF THE EFFECTS OF BRINE ON A COMPACTED CLAY TILL LINER,
Golder Associates, Vancouver (British Columbia).
B. H. Conlin.
IN: Hazardous Wastes in Ground Water: A Soluble Dilemma. National Water Well Association, Dublin, OH. 1985. p 91-100, 9 fig, 4 tab, 23 ref.

Descriptors: *Ponds, *Brines, *Clays, *Soils, *Liners, *Linings, *Path of pollutants, *Hydraulic conductivity, Clay minerals, Groundwater, Monitoring wells, Compaction, Polyethylene liner.

The use of compacted clay or clayey materials as brine pond liners is generally discouraged in Alberta because of poor reported performance. This paper presents the results of a case study involving a comparison of field performance with laboratory test results on a compacted clay till liner at an operating brine pond located near Redwater, Alberta. The study is somewhat unique in that the brine pond was drained prior to relining with high density polyethylene allowing block samples of the liner to be obtained. The liner was exposed to highly concentrated brine solutions for 5 years. Also, a series of frequently sampled ground water monitoring wells around the pond provided some indication of the field performance. The results of the laboratory testing program indicated that long-term (5 years) exposure to brine did not appreciably change the soil fabric, that preconditioning by soaking in brine prior to compaction is an effective method of minimizing the influence of subsequent brine permeation on hydraulic conductivity, and that samples of fresh material could be utilized in the laboratory to model field operating conditions through brine soaking. (See also W89-01661) (Author's abstract)
W89-01671

SPATIAL VARIABILITY OF SOIL PROPERTIES,
California Univ., Riverside.
For primary bibliographic entry see Field 2G.
W89-01870

8E. Rock Mechanics and Geology

EARTHQUAKES, INJECTION WELLS, AND THE PERRY NUCLEAR POWER PLANT, CLEVELAND, OHIO,
Ohio Univ., Athens. Dept. of Geological Sciences.
M. U. Ahmad, and J. A. Smith.
Geology GLGYB, Vol. 16, No. 8, p 739-742, August 1988. 3 fig, 26 ref.

Descriptors: *Earthquakes, *Injection wells, *Geologic fractures, *Underground waste disposal, *Nuclear power plants, Hydrologic models.

On January 31, 1986, an earthquake of Richter magnitude 4.9 occurred in northeastern Ohio 17.0 km south of the Perry Nuclear Power Plant (PNPP) and 12.0 km south of the Calhio injection wells. Accelerometers on site at the PNPP recorded accelerations as high as 0.19 to 0.23 g. Many instruments tripped due to high-amplitude vibrations. Microearthquake networks have recorded 16 microearthquakes within 5.0 km of the injection wells with focal depths ranging from 1.0 to 3.0 km. A hydrological model of an anisotropic reservoir 7.2 km wide and 18.4 km long indicates a pressure buildup of 5.3 MPa at the epicenter and 11.8 MPa at the injection well. The assumption of an anisotropic reservoir is consistent with available geophysical and geologic data. A pressure increase of 11.8 MPa, based on stress ratio estimates in crustal rocks in the region, is more than sufficient to induce failure to a depth of 5.0 km. Brittle faults and extensive fracture permeability within the basement rocks would allow for the migration of pressure transients to hypocentral distances. The indicated pressure buildup of 5.3 MPa at the epicenter may have been sufficient to trigger the earthquake. (Author's abstract)
W89-01335

FOUNDATION TREATMENT IN KARSTIC LIMESTONE: EL CAJON HYDROELECTRIC PROJECT, HONDURAS,
Merritt (A.H.), Gainesville, FL.
A. H. Merritt.
Bulletin of the Association of Engineering Geologists AEGBBU, Vol. 25, No. 3, p 383-391, August 1988. 4 fig.

Descriptors: *Dam foundations, *Karst, *Hydroelectric plants, *Grouting, Dams, Hydraulic structures, Powerplants, Honduras, Construction, Limestone, Caves, Reservoirs, Abutments, Monitoring, Seepage, Dam stability, El Cajon Hydrelectric Plant.

Construction of the El Cajon hydroelectric project in Honduras began in 1980. One of the major aspects of the project was the treatment of the limestone foundation that contained solution features and large caves. Because of the geologic relationship between the limestone and nearby volcanic rocks upstream, the geometry of the grout

curtain is unique. The curtain, developed by grouting between adjacent galleries, begins at the dam, enters the abutments, and then curves upstream to close against the volcanic rocks. The curtain is therefore vertical in the abutments with a transition to a nearly horizontal plane beneath the river. The overall shape is similar to a bathtub with the back of the tub open to the reservoir. A comprehensive monitoring program was initiated when impoundment began in 1985 and will continue for several years. Measurements of seepage, pressures, and displacements are made regularly with periodic review by outside consultants. At the time of this writing, the reservoir is 80% full and the performance of the foundation is considered to be satisfactory. (Author's abstract)
W89-01364

GEORGES BANK - COMMON GROUND OR CONTINUED BATTLEGROUND,
Florida State Univ., Tallahassee. Coll. of Law.
For primary bibliographic entry see Field 6E.
W89-01513

BEDROCK GEOLOGY AND REGIONAL GEOLOGIC SETTING OF COWEETA HYDROLOGIC LABORATORY IN THE EASTERN BLUE RIDGE,
South Carolina Univ., Columbia. Dept. of Geology.
R. D. Hatcher.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 81-92, 4 fig.

Descriptors: *Geology, *Coweeta, *North Carolina, *Geohydrology, Schist, Tectonics, Stratigraphy, Granite, Topography, Metamorphic rocks, Rocks.

The Coweeta syncline occurs in the eastern Blue Ridge of Southwestern North Carolina. Rocks of the eastern Blue Ridge are distinctly different from those of the western Blue Ridge because of their different composition and associations with particular rock types. The name Otto Formation is suggested for a distinctive sequence of metasandstone and aluminous schist that tectonically underlies the Coweeta Group in the Little Tennessee Valley near Otto, North Carolina. The stratigraphic sequences in the Coweeta area consist of the Otto Formation, which is tectonically overlain by the Coweeta Group. Tallulah Falls Formation rocks also occur here, and it is possible that Coweeta Group rocks stratigraphically overlie this unit. Rocks of the eastern Blue Ridge were progressively metamorphosed during the middle Paleozoic to middle and upper amphibolite facies assemblages, and locally to granulite facies, in a Barrovian sequence. Rocks of Coweeta Hydrologic Laboratory area were metamorphosed to the staurolite-kyanite subfacies (lower-middle amphibolite facies). The structure of the Coweeta area is dominated by two early major thrusts, the Shope Fork and Soque River thrusts, which appear to overlie and underlie (respectively) rocks of the Coweeta syncline and were refolded by northeast-trending tight to isoclinal folds and whose axial surfaces dip towards the northwest. Subtle controls of drainage and topography by joints, dip and strike of foliation occur here. Extensive quaternary deposits of colluvium and alluvium serve as surficial aquifers, since they are composed of unconsolidated unstratified or stratified material. Colluvium also moves down slope rapidly in the form of debris avalanches, and slowly in the form of creeping intact masses. (See also W89-01691) (Lantz-PTT)
W89-01696

WEATHERING AND SOIL-FORMING PROCESSES,
Michigan State Univ., East Lansing. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2J.
W89-01697

DEBRIS AVALANCHE AND THE ORIGIN OF FIRST-ORDER STREAMS,
Emory Univ., Atlanta, GA. Dept. of Geology.
W. H. Grant.
IN: Forest Hydrology and Ecology at Coweeta. Ecological Studies, Volume 66. Springer-Verlag, New York. 1988. p 103-110, 7 fig.

Descriptors: *Avalanches, *Geomorphology, *Landslides, *Erosion, *Streambeds, *Streams, Tectonics, Groundwater, Weathering, Chutes.

Debris avalances and underlying joint systems are responsible for some first order streams. The sequence for development of an avalanche associated with first order streams is as follows. A small depression is initiated by the subsoil intersection of two lenticular dilations joints with a downslope striking tectonic joint. Such a configuration could easily occur beneath a small valley. The depression accumulates groundwater. Chemical weathering proceeds faster in the depression enhancing its water capacity. This process can continue indefinitely or be interrupted by a violent storm. A study of a storm in May 1976 in the Coweeta area shows 25 hrs of gradually increasing rainfall which peaked sharply at about 18 to 20 cm/hr. This peak coincided with a debris avalanche. The avalanche was initiated by hydraulic pressure fed through the water saturated subsoil joint system. At the storm peak, pressure was strong enough to break the adhesion between the rock and the water saturated soil and saprolite. The water inflated mass of rock and soil slide quickly down hill, leaving a chute as evidence of its passage. The chute is the locus of a new first order stream which needs only a sustained supply of water to develop into a steep-walled mountain valley. The major subsurface water controls are soil-rock, saprolite-rock interfaces, dilation, and subvertical tectonic joints. Metamorphism tends to promote the development of dilation jointing independent of foliation by reducing the anisotropy of the rock fabric. Thalweg vector plots support the relation between first order streams and joints. The optimum place for a new first order stream to form is on slopes of about 30 degrees which are covered with thin soil and underlain by well jointed sap-rock. (See also W89-01691) (Lantz-PTT)
W89-01698

8F. Concrete

LABORATORY TESTING OF CEMENT-BENTONITE MIX FOR PROPOSED PLASTIC DIAPHRAGM WALL FOR COMPLEXE LAGRANDE RESERVOIR CANIAPISCAU, JAMES BAY, CANADA,
STS Consultants Ltd., Northbrook, IL.
S. A. Gill, and B. R. Christopher.
IN: Hydraulic Barriers in Soil and Rock. American Society for Testing and Materials, Philadelphia, PA. 1985. p 75-92, 3 fig, 4 tab, 15 ref.

Descriptors: *Slurry walls, *Dams, *Cements, *Bentonite, *Cutoff walls, *Slurries, Reservoirs, Trenches, Permeability, Sand, Polymers, Strain, Testing procedures.

A comprehensive laboratory investigation was carried out to determine a suitable mix of cement-bentonite for a slurry trench cutoff wall for Caniapiscau Reservoir project in James Bay, Canada in 1980. Specifications required the mix to have a permeability of less than 0.01 micrometers/second and to be able to sustain a plastic deformation of 10% without fissuring as measured at 90 days in a triaxial compression test with a lateral pressure of 196 kPa. Laboratory samples were prepared with different mixes of cement, bentonite, sand, and water and kept in a curing chamber of 100% humidity. Permeability determination and triaxial compression tests were performed after curing periods ranging from !0 to 120 days. Over 84 specimens were tested. The compression tests included unconfined tests, unconsolidated-undrained tests at a constant rate of strain, unconsolidated-drained tests with varying strain rates and at a controlled rate of stress, and a consolidated-drained test. Permeability tests were performed before and, in some cases, after loading. The specimens were examined for fissures and cracks after a strain of 10%. It was concluded that a mixture of 6% (by weight) Ultra gel 180 bentonite and 160 kg of cement in each cubic meter of the mixture would meet the required specifications. Recommendations for standardized test procedures are made. (See also W89-01612) (Author's abstract)
W89-01618

PRECAST CONCRETE DESIGN FOR TERTIARY WASTE TREATMENT PLANT SIGNIFICANTLY REDUCES TIME AND PROJECT COST,
Burlington Industries, Inc., Greensboro, NC. Architectural and Structural Section.
M. Solomon, and G. A. Rogers.
IN: Proceedings of the 42nd Industrial Waste Conference. Purdue University, West Lafayette, Indiana, May 12-14, 1987. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 447-450, 1 fig, 1 tab.

Descriptors: *Precast concrete, *Wastewater facilities, *Costs, *Construction design, *Italy, Tertiary wastewater treatment, Industrial wastewater, Textile mill wastes, Concrete, Technology transfer.

Burlington Industries, one of the world's largest textile manufacturing corporations, operates over 80 manufacturing facilities throughout the United States and the world. One of Burlington's larger facilities is a plant located in Frosinone, Italy, about 60 miles south of Rome, which produces cotton/polyester leisure wear and uniform fabrics. The Frosinone textile plant is located in a large industrial zone, or region, known as a Consorsio. The Consorsio provides water supply needs and wastewater treatment capacity for all the member industries in the zone. On February 17, 1986, Burlington Industries began a fast track pilot study, design and construction project to design and build a 3 mgd secondary waste treatment plant for the Frosinone operation, so the company would meet federal standards and bypass the limited use Consorsio plant. A new precast concrete system, which had been developed in Europe for containment structures, was used to decrease the construction period. This system offer unique option to conventional cast-in-place construction techniques. The system with an excellent record of structural integrity and leakproof design can offer savings both in time and construction cost over conventional construction methods. It is anticipated that this technology will be available in the United States by the fall of 1987. (See also W89-02006) (Lantz-PTT)
W89-02049

8G. Materials

GEOSYNTHETICS: CLEANUP TOOLS,
Soil and Material Engineers, Inc., Raleigh, NC.
G. Richardson, and J. A. Bove.
Civil Engineering CEWRA9, Vol, 58, No. 8, p 40-42, August 1988. 1 fig.

Descriptors: *Geosynthetics, *Municipal wastes, *Landfills, *Floodwalls, *Liners, *Dikes, *Oil spills, *Cleanup operations, Fuel spills, Environmental sanitation, Environmental engineering.

The use of geosynthetics in liners and drainage systems has become standard in constructing new landfills, and their qualities of chemical resistance, durability and cost effectiveness are also being put to use in environmental remediation projects. The application of geosynthetics to three environmental projects is discussed: (1) as a soil cap placed on a pond filled with organic mucks; the pond contained significant amounts of diesel fuel spilled from an adjacent truckstop; (2) as a cover for a municipal waste landfill; (3) as a reinforcement for a floodwall to keep the Ohio River out of a steel mill's slag heaps. (Sand-PTT)
W89-01346

EVALUATING THE EFFECTIVENESS OF AN ASPHALT CAP AT A SUPERFUND SITE,
JRB Associates, Inc., McLean, VA. Ground Water Section.
For primary bibliographic entry see Field 5E.
W89-01682

GEOSYNTHETICS FOR USE IN WASTE FACILITIES,
S and ME, Inc., Fairfield, OH.
For primary bibliographic entry see Field 5G.
W89-02043

ACCELERATED AGING OF HIGH DENSITY POLYETHYLENE GEOMEMBRANES: A NOVEL APPROACH,
Gundle Lining Systems, Inc., Houston, TX.
For primary bibliographic entry see Field 5E.
W89-02046

8I. Fisheries Engineering

SEASONAL AND SPATIAL DISTRIBUTION OF IRON PRECIPITATING HETEROTROPHS IN WATER AND SEDIMENTS OF FISH PONDS OF DIFFERING FARMING MANAGEMENTS,
Kalyani Univ. (India). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W89-01271

CONTROL OF NUISANCE POPULATIONS OF CRAYFISH WITH TRAPS AND TOXICANTS,
National Fisheries Research Center, La Crosse, WI.
T. D. Bills, and L. L. Marking.
Progressive Fish-Culturist PFCVAY, Vol. 50, No. 2, p 103-106, April 1988. 3 tab, 15 ref.

Descriptors: *Fish hatcheries, *Crayfish, *Chemcontrol, *Trapping, Pyrethroids, Pesticides.

Crayfish have long been a nuisance in fish-rearing ponds at fish hatcheries. The rusty crayfish (Orconectes rusticus) has displaced endemic species and caused serious declines of aquatic plants in some ponds and lakes in the midwestern USA. An attempt was made to evaluate the effect of intensive trapping on a crayfish population and to identify a selective chemical control agent and evaluate its effectiveness under field conditions. A crayfish population in a small pond was suppressed but not eliminated by trapping; adults were effectively harvested but efficiency diminished sharply as the population declined. Of 19 chemicals tested as possible control agents for crayfish, a synthetic pyrethroid (Baythroid) was by far the most toxic; 25 micrograms/L produced a complete kill of crayfish in the pond and was also the most selective for crayfish in laboratory tests. (Author's abstract)
W89-01345

SUBLETHAL TOXICITY AND ACCUMULATION OF CADMIUM IN TILAPIA AUREA,
Agricultural Coll. of Athens (Greece). Dept. of Applied Hydrobiology.
For primary bibliographic entry see Field 5C.
W89-01398

EFFECT OF OXYGEN ON THE GROWTH OF YOUNG AYU, (IN JAPANESE),
Tokyo Univ. (Japan).
For primary bibliographic entry see Field 2H.
W89-01509

GEORGES BANK - COMMON GROUND OR CONTINUED BATTLEGROUND,
Florida State Univ., Tallahassee. Coll. of Law.
For primary bibliographic entry see Field 6E.
W89-01513

INSTREAM FLOWS NEEDED FOR SUCCESSFUL MIGRATION SPAWNING AND REARING OF RAINBOW AND WESTSLOPE CUTTHROAT TROUT IN SELECTED TRIBUTARIES OF THE KOOTENAI RIVER,
Montana Dept. of Fish, Wildlife and Parks, Kalispell.
For primary bibliographic entry see Field 2H.
W89-01775

BIOLOGICAL AND PHYSICAL INVENTORY OF THE STREAMS WITHIN THE NEZ PERCE RESERVATION: JUVENILE STEELHEAD SURVEY AND FACTORS THAT AFFECT ABUNDANCE IN SELECTED STREAMS IN THE LOWER CLEARWATER RIVER BASIN, IDAHO,
Nez Perce Tribe, Lapwai, ID. Fisheries Resource Management.
For primary bibliographic entry see Field 2H.
W89-01776

IDAHO HABITAT EVALUATION FOR OFF-SITE MITIGATION RECORD: ANNUAL REPORT 1985,
Idaho Dept. of Fish and Game, Boise.
For primary bibliographic entry see Field 2H.
W89-01777

INVERTEBRATE FISH FOOD RESOURCES OF LOTIC ENVIRONMENTS,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 2H.
W89-01802

FISH PASSAGE, CONTROL DEVICES AND SPAWNING CHANNELS,
Ministry of Works and Development, Wellington (New Zealand).
I. G. Jowett.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 138-155, 6 tab, 20 ref.

Descriptors: *Fish passages, *Spawning channels, *Fish handling facilities, *New Zealand, *Hydroelectric plants, Salmon, Whitebait, Spawning, Dams, Fish migration.

The construction of a hydroelectric power scheme on a river usually creates a barrier or impediment to the passage of fish travelling either upstream or downstream. This may adversely affect the fish population depending upon the river, the fish species involved and the location of their spawning grounds. Some of the fish species present in New Zealand, such as quinnat salmon, whitebait and some bullies, spawn in freshwater and the young in the form of eggs, larvae or juveniles move into the sea for a period before returning to freshwater to complete the life cycle. Some fish, such as eels, are catadromous, that is the adults migrate to the sea to spawn and the offspring move back into freshwater to complete the life cycle. Other species may reside in freshwater for their entire life but migrate from their residential areas to spawning areas. The need to maintain continuity between upstream and downstream fish populations, each of which can exist separately, is less clear-cut. The measures taken to maintain the fish population are usually either the provision of passage facilities or the provision of artificial spawning and rearing areas such as in spawning races and hatcheries. This chapter reviews information on the passage of fish past barriers, the problems associated with guiding or excluding fish and the construction and operation of spawning channels. It also discusses provisions which have been made on New Zealand hydroelectric schemes. (See also W89-01871) (Lantz-PTT)
W89-01883

TROUT HATCHERIES AND FISH STOCKING,
Ministry of Agriculture and Fisheries, Christchurch (New Zealand).
R. T. Hutchinson.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 156-167, 1 tab, 4 ref.

Descriptors: *Fish hatcheries, *Trout, *Fish stocking, *New Zealand, Hydroelectric plants, Case studies, Hawkes Bay, Hawara, Wellington, Fish management.

Hatchery facilities currently operating throughout New Zealand raise trout, charr and hybrids for release into recreational fisheries and salmon for the enhancement of stocks utilized by both recreational and commercial interests. Those facilities which are involved in salmon culture only, are excluded from this paper. Hatchery facilities vary little in basic design but range in size and production capability from servicing local or district requirements, upward to those which supply limited national demands. Of the present hatchery establishments those serving district requirements are the facilities operated by the Hawke's Bay, Hawara and Wellington Acclimatization Societies, and the Wildlife Service (Department of Internal Affairs) hatchery at Wanaka. The Wildlife Service hatcheries at Ngongotaha and Turangi, presently the largest in terms of both actual and potential production of trout, supply requirements additional to regional commitments. Only the three Wildlife Service hatcheries continue any direct involvement in management or investigational stocking of hydroelectric reservoirs. This chapter outlines hatchery methods and techniques and reviews hydroelectric power system hatchery release programs. (See also W89-01871) (Lantz-PTT)
W89-01884

FISH AND FISHERIES,
Ministry of Agriculture and Fisheries, Christchurch (New Zealand). Fisheries Research Div.
S. F. Davis, and L. D. Teirney.
IN: Aquatic Biology and Hydroelectric Power Development in New Zealand. Oxford University Press, New York. 1987. p 237-263, 3 fig, 1 tab, 3 plates, 56 ref.

Descriptors: *Fish, *Fisheries, *Ecological effects, *New Zealand, *Hydroelectric plants, Tongariro power development, Water resources development, Case studies, Political aspects, Social aspects, Economic aspects.

The history of interactions between hydro-development and fisheries agencies in New Zealand is described. The country's freshwater fisheries resources and the uses made of them and how this resource is and has been managed. The Tongariro power scheme is used as a case study to illustrate the complex range of effects of hydro-development on fisheries, and as an example of a large-scale fisheries investigation associated with hydro-development. Finally, there is a discussion of current political and technical approaches being adopted to ensure that fisheries values are maintained and conserved as development of the nation's water resources proceeds. (See also W89-01871) (Lantz-PTT)
W89-01890

LABORATORY SIMULATION OF FISH PASSAGE THROUGH A HEATED-WATER DISCHARGE,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5C.
W89-01902

TOXIC CONTAMINATION IN LARGE LAKES. VOLUME II: IMPACT OF TOXIC CONTAMINANTS ON FISHERIES MANAGEMENT.
For primary bibliographic entry see Field 5C.
W89-02137

FISHERIES MANAGEMENT, WATER QUALITY AND ECONOMIC IMPACTS: A CASE STUDY OF LAKE KINNERET,
Kinneret Limnological Lab., Tiberias (Israel).
M. Gophen.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 5-24, 5 fig, 6 tab, 44 ref.

Descriptors: *Water quality, *Economic impact, *Lake Kinneret, *Israel, *Fisheries management, *Management planning, Grey mullet, Carp, Fish, Zooplankton, Biomass, Case studies, St. Peters fish, Pesticides.

Lake Kinneret, Israel, currently supplies 35% (400-430 times 10 to the 6th power cu m/yr) of the

national water consumption. Of this, the proportion supplied for domestic use is increasing rapidly because of larger demands. The lake is also utilized for fisheries (1800 tons/yr, i.e. 106 kg/ha), recreation and tourism. Although the top national priority for lake utilization is water supply, fisheries, especially stocking management policy, affect water quality. Two-thirds of the fishery income is due to stocked species; 40% - grey mullet, 35% - St. Peter's fish, 15% - silver carp, and 10% - blue tilapia. Recently, zooplankton biomass decreased, the densities of small cladocerans relative to large ones increased, and a reduction in Bosmina body size was observed Daphnia lumholtzi disappeared from lake Kinneret. Consequently, there was an intensification of fish predation on zooplankton, the major food source in summer. As a result, the biomass of nanoplankton increased, causing water quality deterioration. Introduced fingerlings contributed 150-320 and 85-150 kg (catch)/1,000 fingerlings/yr during 1954-1962 and 1962-1984, respectively. Stock-catch correlation values were high (r-squared = 0.78) when introduction varied between 500,000 -4,000,000 fingerlings/yr of all stocked fish. Fishery management recommendations aimed at prevention of water quality deterioration, as well as sufficient income, are: elimination of blue tilapia and silver carp stocking; annual introduction of 5,000,000 - St. Peter's fish fingerlings and 1,000,000 - grey mullet fingerlings; intensification of bleak exploitation; and prevention of criminal utilization of pesticides for fishery. (See also W89-02137) (Author's abstract)
W89-02138

FISHERY TRANSFORMATION ON LAKE MANZALA, EGYPT DURING THE PERIOD 1920 TO 1980,
Manitoba Dept. of Natural Resources, Winnipeg.
D. R. Toews.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 25-50, 2 fig, 7 tab, 16 ref.

Descriptors: *Water pollution effects, *Lake Manzala, *Egypt, *Fisheries, Water quality, Brackish water, Evapotranspiration, Fisheries management, Heavy metals, Pesticides, Nutrients.

Lake Manzala, a brackish lake in the Nile Delta region of Egypt has been impacted by anthropological and environmental factors over the past 60 years. During this period salinities have declined and nutrient loading has increased on Lake Manzala, in response to a two or three fold increase in agricultural drainwater flows, reduced evaporation due to approximately 50% reduction in lake area resulting from agricultural land reclamation and increased domestic sewage outfall from Cairo. Impacts of long-term water quality changes to fishing area: a transformation from a marine mullet to a freshwater tilapia-dominated fishery; a seven fold increase in yield per unit area; a two or three fold increase in gross catch value per unit area; a four fold increase in primary employment in terms of number of fisherman per unit area. Existing regional differences in primary production, fish standing stock, fish yield and fishing effort are a function of drainwater impact. Areas unaffected by drainwater have not significantly changed over time. Levels of heavy metals and pesticides in the water column in sediments and in fish are somewhat elevated in drainwater outfall areas but within acceptable levels. Nutrient loads are expected to double by the year 2000. It is proposed that long term fisheries development on Lake Manzala be based on the enriched freshwater tilapia model and on the optimal utilization of existing and projected future increases in nutrient loading. (See also W89-02137) (Author's abstract)
W89-02139

UNITING HABITAT QUALITY AND FISHERY PROGRAMS IN THE GREAT LAKES,
Great Lakes Fishery Commission, Ann Arbor, MI.,
For primary bibliographic entry see Field 5G.
W89-02141

RIVERINE AND OTHER TROPICAL LAKES AND THEIR FISHERIES,
East-West Center, Honolulu, HI.
For primary bibliographic entry see Field 2H.
W89-02143

EFFECTS OF CONTAMINANTS LOADINGS ON FISHERIES YIELDS FROM LARGE LAKES,
Ontario Ministry of Natural Resources, Thunder Bay. Fisheries Research Section.
For primary bibliographic entry see Field 5C.
W89-02145

PERSPECTIVES ON THE INFLUENCE OF TOXIC SUBSTANCES ON FISHERY PRODUCTIVITY,
Minnesota Univ., St. Paul. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 5C.
W89-02147

RESTOCKING OF GREAT LAKES FISHES AND REDUCTION OF ENVIRONMENTAL CONTAMINANTS 1960-1980,
Michigan State Univ., East Lansing.
H. A. Tanner.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 209-227.

Descriptors: *Great Lakes, *Cleanup operations, *Fish stocking, *Water pollution effects, *Lake restoration, *Water quality control, *Lakes, Toxicity, Water pollution treatment, Salmon, Trout, Costs, Organic compounds, Pesticides, DDT, Polychlorinated biphenyls.

The Great Lakes of North America total 260,000 sq km in area and constitutes a significant portion of the world's freshwater. From 1800 to 1950 this watershed was changed from a wilderness into the industrial heartland of North America. During this period there occurred extensive overexploitation of fish stocks, increased sedimentation and widespread pollution from cities and industry. Since 1950, pollution control programs have achieved major improvements in water quality. Contaminants with toxicity of long duration, DDT, PCB, Hg, dieldrin, toxaphene, mirex and others, have been the slowest to respond to cleanup efforts. The stocking of salmonids to restore the predacious elements of the food web, lost to excessive commercial fishing and the parasitic depredations of the sea lamprey, began in the late 1950s. The riparian states, Ontario and the federal governments of Canada and the U.S. have stocked chinook, coho, pink salmon, lake trout, steelhead, brown trout and Atlantic salmon. Because of contaminants the sale of fish has at times been restricted or banned. Sport anglers have received health warnings. The fisheries of the Great Lakes have been restored and expanded by restocking, reduced commercial fishing and sea lamprey control. Sportfishing generates annually at least $2 billion in economic activity. This program, beset by the negative impacts of contamination, has included prudent restrictions and warnings to consumers consistent with levels of risk. Contaminants continue to decline and the health and economic worth of the fishery continue to improve. (See also W89-02137) (Author's abstract)
W89-02148

FISHES, FISHING AND POLLUTION IN LAKE VANERN (SWEDEN),
Eco Research and Resource Planning, Bromma (Sweden).
B. Lundholm.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 229-249, 13 fig, 4 tab, 10 ref.

Descriptors: *Lake Vanern, *Sweden, *Water pollution effects, *Cleanup operations, *Fish, *Fishing, *Lakes, *Lake restoration, Salmon, Mercury, Hydrogen ion concentration, Fish stocking, Fish populations, Species diversity, Pike.

Lake Vanern is the third largest lake in Europe. Once it was a good salmon lake, but industrial emissions and hydroelectrical exploitations have affected fish populations and fishing. In 1965 high Hg levels were found in pike. At the same time, the pH in the lake as dropping and local eutrophication was recorded. Problems with fishing appeared. The commercial catch of salmon in 1970 was down to half a ton. Thanks to new laws and regulations those trends are now broken. Mercury levels are decreasing, the pH is slowly increasing and the water quality as measured by transparency is improving. Fish catches are also increasing, but the catches of salmonids are still far below the preindustrial catches. The changes of the salmonid populations are of special interest as there are plans to increase the number of salmon to create a base for an intensive sport fishery, which can give new jobs which are desperately needed. Restoring the natural reproduction is difficult as the remaining populations are very small and possible reproduction sites are few. An increase of the salmonids in the lake must be based on stock from hatcheries. The present breeding stocks in the hatcheries is also very small and genetic investigations have shown that the genetic variability has been lost. There are now plans to protect and rebuild the local populations and if possible restore the genetic variability. It is, however, important that the smolts from the hatcheries are released in a way so they do not interfere with the natural populations. The goal is to re-establish Lake Venern to the best salmon lake in Europe. (See also W89-02137) (Author's abstract)
W89-02149

ADMINISTRATION OF THE FISH CONTAMINANT PROGRAM IN A DECENTRALIZED STATE AGENCY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
For primary bibliographic entry see Field 6E.
W89-02150

FRESHWATER FISHERIES MANAGEMENT AND POLLUTION IN BRITAIN: AN OVERVIEW,
Liverpool Univ. (England). Dept. of Zoology.
K. O'Hara.
IN: Toxic Contamination in Large Lakes. Volume II: Impact of Toxic Contaminants on Fisheries Management. Lewis Publishers, Chelsea, Michigan, 1988. p 265-280, 1 fig, 2 tab, 26 ref.

Descriptors: *Water pollution effects, *England, *Management planning, *Fisheries, Salmon, Trout, Eel, Fish kill, Acidification, Toxicity, Fishing, Water pollution prevention.

The most serious effects of toxic pollution in freshwaters in Britain have been exhibited in rivers, with amelioration measures being directed at these problems. Freshwater fish in Britain are divided into game (salmonid) and coarse fishes, but total only 54 species. Coarse fishermen normally return all captured fish alive to the water body. In most intensively angled trout lake fisheries, fish are stocked as hatchery-reared, table-size fish and the majority of trout fisheries are of good water quality. Other than Atlantic salmon, sea trout and eel fisheries, only minor commercial freshwater fisheries for food exist, with very few in lakes. Human health problems associated with consumption of freshwater fish are therefore not perceived as a major concern. The different types of stillwater environments found in Britain are compared and their utilization by anglers described. Fish kill incidents have been calculated from contrasting areas and the occurrence of toxic induced problems, including those associated with acidification, are assessed. Information sources available to the public and anglers are assessed and two case studies, acidification and lead poisoning in swans are used to illustrate fisheries management related problems. It is likely that current practices of fisheries management will remain in the foreseeable future; with most major large coarse fisheries being more or less naturally controlled and trout fisheries in lakes, which are intensively angled, relying on artificial stocking. Pollution control of rivers will

remain the principal area of activity, although eutrophication effects will have continued importance for still waters. (See also W89-02137) (Lantz-PTT)
W89-02151

YAKIMA RIVER SPRING CHINOOK ENHANCEMENT STUDY. ANNUAL REPORT FY 1986,
Colorado Dept. of Local Affairs, Denver.
D. E. Fast, J. D. Hubble, and B. D. Watson.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009902. Price codes: A10 in paper copy, A01 in microfiche. DOE Report No. DOE/BP/39461--T1, November 1986. 188p, 30 fig, 55 tab, 21 ref, 3 append. DOE Contract DE-AI79-83BP39461, Project No. 82-16.

Descriptors: *Fish populations, *Fisheries, *Yakima River, *Chinook salmon, *Salmon, Ecology, Dams, Smolt, Wapatox River, Naches River, Fish eggs, Reservoirs, Roza Dam, Horn Rapids, Prosser Dam, Fish migration, Fish hatcheries.

A total of eight spring chinook redds were successfully capped in 1986. The mean survival to emergence was 56.7% and ranged from 21.9 to 90.0%. The smolt outmigration was monitored at Wapatox on the Naches River and Prosser on the lower Yakima. The spring outmigration at Wapatox was estimated to be 6,671 smolts. The 1986 outmigration of wild spring chinook from the Yakima Basin was estimated to be 169,076 smolts at Prosser. The survival from egg to smolt was calculated using the 1984 redd counts and the 1986 smolt outmigration at Prosser. In 1986 a total of 8,557 adult and 349 jack spring chinook salmon returning to the Yakima River were counted at Prosser fish ladder. This gives a total of 8,906 salmon returning to Prosser Dam. The median dates of passage were May 18 and May 26 for adults and jacks respectively. An additional 530 fish were estimated to have been caught in the Yakima River subsistence dipnet fishery below Horn Rapids and Prosser Dams. Therefore, total return to the Yakima system was 9,442 spring chinook salmon. Spring chinook were counted at Roza Dam from May 13 to September 30, 1986. Passage at Roza Dam was 2,967 adult and 284 jack spring chinook for a total of 3,251 fish. The median dates of passage at Roza Dam were June 6 and June 23 for spring chinook adults and jacks respectively. The smolt to adult (S sub sa) survival was calculated based on the 1983 smolt outmigration estimated at Prosser and the 1984 return of jacks (3 year old fish), the 1985 return of four year old adults, and the 1986 return of five year old fish to the Yakima River. It was estimated that 6,102 wild three, four, and five year old fish returned from an estimated smolt outmigration of 135,548 fish in 1983. This gives an estimated survival from smolt to adult of 4.4%. (Lantz-PTT)
W89-02260

9. MANPOWER, GRANTS AND FACILITIES

9A. Education (Extramural)

SOFTWARE FOR TEACHING PRINCIPLES OF CHEMICAL MOVEMENT IN SOIL,
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W89-02208

10. SCIENTIFIC AND TECHNICAL INFORMATION

10C. Secondary Publication And Distribution

SYSTEMS ANALYSIS,
North Carolina Agricultural and Technical State Univ., Greensboro. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W89-01461

ECONOMICS,
East Texas State Univ., Commerce.
For primary bibliographic entry see Field 6B.
W89-01462

LAW (1987 AMENDMENTS),
Nixon, Hargraves, and Doyle, Rochester, NY.
For primary bibliographic entry see Field 6E.
W89-01463

INORGANICS,
Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA. Montgomery Labs.
For primary bibliographic entry see Field 5A.
W89-01464

ORGANICS,
Tennessee Technological Univ., Cookeville.
For primary bibliographic entry see Field 5A.
W89-01465

WATER CHARACTERISTICS,
For primary bibliographic entry see Field 5A.
W89-01466

CONTINUOUS MONITORING, AUTOMATED ANALYSIS, AND SAMPLING PROCEDURES,
Oak Ridge National Lab., TN. Waste Management Technology Center.
For primary bibliographic entry see Field 7B.
W89-01467

WASTEWATER COLLECTION,
RJN Environmental Associates, Inc., Wheaton, IL.
For primary bibliographic entry see Field 5D.
W89-01468

WASTEWATER TREATMENT: PHYSICAL AND CHEMICAL METHODS,
Maryland Univ., College Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-01469

ACTIVATED SLUDGE,
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-01470

BIOLOGICAL FIXED-FILM SYSTEMS,
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